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FINAL LAB AREA FOCUSED FEASIBILITY STUDY NSWC INDIAN HEAD MD
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CH2MHILL

Final

Lab Area Focused Feasibility Study

Naval Support Facility Indian Head
Indian Head, Maryland

Contract Task Order 051

December 2009

Prepared for

Department of the Navy
Naval Facilities Engineering Command Washington

Under the

LANTDIV CLEAN III Program
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Prepared by

CH2MHILL

Chantilly, Virginia

Executive Summary

This document presents the Focused Feasibility Study (FFS) to address the soil and sediment contamination at the Lab Area at Naval Support Facility, Indian Head (NSF-IH), Indian Head, Maryland. This FFS report was prepared by CH2M HILL under the U.S. Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Comprehensive Long-Term Environmental Action Navy III Contract No. N62470-02-D-3052, Contract Task Order 0051. This report documents the evaluation of remedial action alternatives to address contamination associated with the Lab Area soil and sediment. Shallow groundwater has not been encountered at the site, and therefore, was not identified as a pathway for transport or exposure. The information presented herein will be used by the Navy and regulatory agencies to select a remedial alternative (RA) for the site that complies with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan.

The Lab Area covers approximately 14 acres and is located in the northeastern area of NSF-IH. The Lab Area consists of Sites 14,15, 16, 49, 50, 53, 54, and 55, which were individually investigated prior to 2000. Most of the area contains maintained grassy areas and trees. The areas around the buildings consist of paved roads, parking areas, and lawn. The buildings are generally clustered near the top of a gradual hill that slopes downward towards the southeast and south. Historical sources of metals in the soil include various disposal practices, accidental releases of laboratory chemicals containing mercury into the sewer system, and lead-based paint from the buildings.

During the RI, the Chemical Disposal Pit (Site 49) was removed, and a risk assessment was conducted on confirmatory surface soil samples just outside the perimeter of the excavation, as well as on the subsurface soil sample just below the excavation. The results demonstrated that the constituent levels were within EPA’s acceptable risk ranges to human or ecological receptors. Sites 14 and 49 are collocated with each other and consequently, data obtained for Site 49 were also considered representative of Site 14, and results of the RI were considered sufficient to document closure of the both Sites 14 and 49. As a result, these sites were determined to require NFA and do not undergo an evaluation of remedial alternatives in this FFS. The remedial alternatives evaluation is applied to the other sites in the Lab Area, which include Sites 15, 16, 50, 53, 54, 55, Other Buildings (303, 304, 555, and 596), and Wetland Area.

The FFS uses information gathered from previous investigations relevant to Lab Area, primarily the Final Remedial Investigation report (CH2M HILL, 2004) and the Baseline Ecological Risk Assessment report prepared in 2006 by CH2M HILL, to document the analyses and evaluation used to develop remedial action objectives (RAOs) and alternatives for this site.

The primary constituents of concern in Lab Area soil and wetland sediment are mercury and lead. The site-specific RAOs at the Lab Area are:

1. Reduce risks to human receptors from exposure to mercury and lead in the surface soil in the Upland Area to acceptable levels under industrial land use and residential use scenarios
2. Reduce risks to human receptors from exposure to mercury potentially present in and around sewer pipes in the Upland Area to acceptable levels under industrial land use scenario
3. Reduce risks to ecological receptors from exposures to mercury in the sediment in the Wetland Area to acceptable levels
4. Reduce risks to human receptors from exposure to arsenic in the sediment in the Wetland Area to acceptable levels.

No remedial alternative was developed or evaluated for Sites 14 and 49 because of the NFA determination for these two sites.

For the remaining sites within the Lab Area, three remedial alternatives that would satisfy the RAOs were developed and evaluated against the NCP criteria in the FFS, as summarized below.

- Alternative 1: No Action
- Alternative 2: Institutional Controls (ICs)
- Alternative 3: Excavation of Surface Soil and Emergent Wetland Sediment, Off Site Disposal, Site Restoration, and ICs

Based on the findings of the comparative analysis, Alternative 3 satisfies the site-specific RAOs, is protective of human health and the environment, and is in compliance with applicable or relevant and appropriate requirements.

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Acronyms and Abbreviations

AA	area of attainment
ARARs	Applicable or Relevant and Appropriate Requirements
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	cubic feet
CFR	Code of Federal Regulations
COCs	contaminants of concern
COPCs	constituents of potential concern
CWAP	comprehensive work approval permit
CY	cubic yard(s)
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
GRAs	General Response Actions
HHRA	human health risk assessment
IC	institutional control
IEUBK	Integrated Exposure Uptake Biokinetic
IHIRT	Indian Head Installation Restoration Team
MDE	Maryland Department of the Environment
mg/kg	milligram(s) per kilogram
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NSF-IH	Naval Support Facility, Indian Head
O&M	operations and maintenance
OWAP	Old Waste Acid Pit
PA	preliminary assessment
PAHs	polycyclic aromatic hydrocarbons
PRGs	Preliminary Remediation Goals
RA	remedial alternative
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SERA	screening-level ecological risk assessment
SF	square feet
SI	site investigation
SRGs	Site Remediation Goals
SVOCs	semivolatile organic compounds
TAL	target analyte list
TBC	to be considered
UCL	upper confidence limit
VOC	volatile organic compound

SECTION 1

Introduction

This report presents the Focused Feasibility Study (FFS) for the Lab Area at Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland (Figure 1-1). This FFS report was prepared by CH2M HILL under the Naval Facilities Engineering Command (NAVFAC), Atlantic Division, Comprehensive Long-Term Environmental Action Navy III Contract Number N62470-02-D-3052, Contract Task Order 0051, for submittal to the Navy, the U.S. Environmental Protection Agency (EPA), and the Maryland Department of the Environment (MDE). NSF-IH was placed on EPA's National Priorities List in September 1995. This FFS is part of the overall Installation Restoration Program being implemented at the Lab Area.

The FFS for the Lab Area has been developed to the extent applicable in accordance with *Interim Final, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988); other Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requirements, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and implemented by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] 300); and other relevant EPA guidance.

The Lab Area is located in the northeastern area of Main Installation. It consists of the following sites:

- Site 14 – Waste Acid Disposal Pit
- Site 15 - Mercury Deposits in Manhole, Fluorine Lab (Buildings 103 and 502 sewers)
- Site 16 - Laboratory Chemical Disposal (Building 600 sewers)
- Site 49 - Chemical Disposal Pit
- Site 50 - Building 103 Crawl Space
- Site 53 - Mercury Contamination of the Sewage System
- Site 54 - Building 101
- Site 55 - Building 102
- Other Buildings (Buildings 303, 304, 555, and 596)
- Wetland Area

Because of similar historic usage, proximity, the sharing of sewer utilities, and overlapping field investigations, the U.S. Navy, MDE, and EPA decided at a meeting on May 11, 2000 to simply refer to the area encompassing these sites as the "Lab Area." The approximate boundary of the Lab Area, as defined at the meeting, is shown in Figure 1-1.

For the purpose of this FFS, the following site-specific terms will be used throughout this document to identify the two areas that are discussed: the Upland Area, consisting of the buildings and roads within the site boundary, and the Wetland Area, consisting of the emergent wetland located at a low point downgradient of the site and within the site boundary.

1.1 Objective and Approach

The FFS used information gathered from various investigations, described in Section 2, to develop and evaluate cost-effective alternatives to address surface soil contamination at the Upland Area and sediment contamination in the Wetland Area. Based on the human health risk assessment (HHRA; CH2M HILL, 2004), screening-level ecological risk assessment (SERA; CH2M HILL, 2004), and baseline ecological risk assessment (BERA; CH2M HILL, 2006), no contaminants of concern (COCs) were identified for surface water at this site; therefore, a remedial action is not warranted for this medium. During drilling activities in previous investigations, groundwater was not encountered at depths to about 40 feet below ground surface (bgs), so groundwater has not been identified as a pathway for transport or exposure. As a result, no further action is warranted for the shallow groundwater.

During the RI, the Chemical Disposal Pit (Site 49) was removed, and a risk assessment was conducted on confirmatory surface soil samples just outside the perimeter of the excavation, as well as on the subsurface soil sample just below the excavation. The results demonstrated that the constituent levels were within EPA’s acceptable risk ranges to human or ecological receptors. Sites 14 and 49 are collocated with each other and consequently, data obtained for Site 49 were also considered representative of Site 14, and results of the RI were considered sufficient to document closure of the both Sites 14 and 49. As a result, these sites were determined to require NFA and do not undergo an evaluation of remedial alternatives in this FFS. The remedial alternatives evaluation is applied to the other sites in the Lab Area, which include Sites 15, 16, 50, 53, 54, 55, Other Buildings (303, 304, 555, and 596) and Wetland Area.

The remedial alternatives (RAs) discussed in this FFS address remedial action objectives (RAOs) and risks associated with the surface soil and sediment at the site. This FFS report includes a site-specific explanation of how each alternative satisfies the NCP’s nine site-specific remedy selection criteria. It also documents the analyses and evaluations used to develop the RAs. The information presented herein will be used by the Navy and regulatory agencies to select an RA for the Upland Area and Wetland Area that complies with the requirements of the NCP.

This FFS report is not intended to serve as a design document; rather, it gives a conceptual overview of RAs and an assessment of their feasibility. It discusses the criteria used to evaluate the RAs and to assess the benefits of implementing them. Following completion of the FFS, a recommended alternative that best satisfies the RAOs will be presented in a Proposed Plan that will be submitted for public comment. The resulting comments will be reviewed, and a remedy will be selected and formally documented in a Record of Decision (ROD).

1.2 Report Organization

This FFS report is organized into six sections:

1. Introduction
2. Background Information

3. Remedial Action Objectives, Applicable or Relevant and Appropriate Requirements (ARARs), and Site Remediation Goals (SRGs), and Areas of Attainment (AAs)
4. Identification and Screening of Remedial Technologies and Assembly of Remedial Alternatives
5. Description and Detailed Analysis of Remedial Alternatives
6. References

Figures and tables referenced within the text are provided at the end of each section. Appendices referenced within the text are provided at the end of Section 6.

\\APHRODITE\PROJ\USNAVFACENGCOM\INDIANHEAD\MAPFILES\LAB_AREA_FFS\FIGURE 1-1 - FACILITY LOCATION.MXD FIGURE 1-1 - FACILITY LOCATION.MXD MRISSING 6/25/2009 16:55:13

Legend

- Topographic Contours
- Approximate Lab Area Site Boundary
- Buildings
- Roads and Paved Areas
- Wooded Area
- Water Bodies
- NSF-IH Base Boundary

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Figure 1-1
Facility Location
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

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SECTION 2

Background Information

This section summarizes the NSF-IH base history, site history and characteristics, previous investigations and removal actions, human health and ecological risks, and the nature and extent of contamination at the Lab Area. Detailed information is provided in the following documents:

- CH2M HILL. 2004. *Final Remedial Investigation Report for the Lab Area (Sites 15, 16, 49, 50, 53, 54, and 55), Naval District Washington, Indian Head, Indian Head, Maryland*. Herein referred to as the remedial investigation (RI) report.
- Ensafe/Allen & Hoshall, 1994. *Final Site Inspection Report, Phase II Indian Head Division, Naval Surface Warfare Center*. Herein referred to as the Phase II report.
- Naval Energy and Environmental Support Activity (NEESA), 1992. *Preliminary Assessment, NSWC, Indian Head Division, Indian Head, Maryland*. Herein referred to as the preliminary assessment (PA) report.

2.1 Base Location and History

NSF-IH is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC (Figure 1-1). NSF-IH is a Navy facility consisting of the Main Installation on Cornwallis Neck Peninsula and the Stump Neck Annex on Stump Neck Peninsula. The Main Installation encompasses approximately 2,500 acres and is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast. Included as part of the Main Installation are Marsh Island and Thoroughfare Island, which are located in Mattawoman Creek. The Lab Area and downgradient Wetland Area are located on the Main Installation (Figure 1-1).

NSF-IH was established in 1890 and is the Navy's oldest continuously operating ordnance station. At various times during its operation, NSF-IH has served as a gun and armor proving ground, a powder factory, a propellant plant, and a research facility. Stump Neck Annex, which was acquired in 1901, provided a safety buffer for larger naval guns that were tested by firing into the Potomac River and at Stump Neck. The production of gunpowder and development of new explosives during the onset of World War II resulted in the construction of several new facilities at the base, as well as the construction of Route 210 as a Defense Access Road in 1943. Development and improvements at the base continued throughout the 1950s and 1960s, and in 1966, the base was renamed the Naval Ordnance Station (NOS).

After the Vietnam conflict, the mission of NSF-IH shifted from serving primarily as a production facility to a highly technical engineering support operation. In 1987, the NOS was named as a Center for Excellence to promote technological excellence in the following specialized fields: energetic chemicals; guns, rockets and missile propulsion; ordnance devices; explosives; safety and environmental protection; and simulators and training

(Parsons, 2000). Current Navy land uses at NSF-IH are operations and training; production; maintenance and utilities; research, development, testing, and evaluation; explosive storage; supply and nonexplosive storage; administration; community facilities and services; housing; and open space.

2.2 Site History and Characteristics

2.2.1 Site History

The Lab Area covers approximately 14 acres and consists of Sites 15, 16, 49, 50, 53, 54, and 55. Most of the area contains maintained grassy areas and trees, mostly oaks. The areas around the buildings consist of paved roads, parking areas, and lawn. The buildings are generally clustered near the top of a gradual hill that slopes downward towards the southeast and south. The approximate boundary of the Lab Area, and the various sites it contains, and the site layout, including the network of the sewer lines and manholes, are shown in Figure 2-1. Detailed histories of the sites investigated in this FFS report are presented in the PA report, Phase II report, and/or the RI report. A summary of each site, taken from one or more of the three reports, is provided below.

Site 14 – Old Waste Acid Disposal Pit

Site 14, the OWAP, was not included as part of the Lab Area RI; however, the OWAP was thought to be in close proximity to the Lab Area, and, specifically, in close proximity to the Chemical Disposal Pit (Site 49). The IAS (NEESA, 1983) and the PA (NEESA, 1992) both described that the OWAP was removed and filled in with concrete in 1975; however the location of the OWAP was not determined.

Since the IAS and PA, further research by NDWIH personnel (as well as the Lab Area RI field investigation) suggested that the Chemical Disposal Pit might have been built on top of the OWAP location. Specifically, an interview with a retired Lab Area worker of 40 years (Baroody, 2001), revealed that after digging out the OWAP and filling it with concrete in the early 1970s, the Chemical Disposal Pit was installed on top of the abandoned OWAP.

Site 15 – Mercury Deposits in Manhole, Fluorine Lab

Site 15 is the location of the Surveillance/Sample Control Building (Building 103) and the Fluorine Laboratory (Building 502) , which were constructed in 1902 and 1942, respectively. Building 103 contained facilities to analyze raw materials and manufactured propellants for surveillance tests. Laboratory equipment containing mercury was reportedly used at different times throughout the history of Building 103. The equipment included nitrometers, pycnometers, talianis, and thermometers. Liquid wastes from this facility consisted of water, acetone, and alcohol used to wash laboratory glassware.

Building 502 housed a laboratory to develop, provide, and analyze bench-scale quantities of experimental chemicals and fuels. The extensive variety of products and processes developed in Building 502 required a large amount of equipment, such as water aspirators and condensers of different size and capacities, as well as jacketed reactors and vessels with up to 50 gallons in capacity.

The wastewater from Buildings 103 and 502 was discharged through underground pipes and combined in a storm drain manhole approximately 100 feet from Building 502. From this manhole, the wastewater flowed in a southeasterly direction, eventually emptying into Mattawoman Creek. This manhole received wastewater discharge four days per week between 1942 and the late 1980s. Contaminants known to be in the wastewater included mercury, lead, total suspended solids, and oil/grease. In 1969, 10 pounds of mercury were recovered from this manhole (NEESA, 1992). Average combined wastewater discharges from Buildings 103 and 502 into the manhole were estimated to be 1,150 gallons per day, or 4,600 gallons per week over the more than 40-year period of operation (NEESA, 1992).

Site 16 – Laboratory Chemical Disposal System

Site 16 consists of the sewers draining the Research and Development Building (Building 600). Building 600 housed the chemical research laboratories and division offices. Reportedly, waste chemicals were disposed of into the plumbing system, where they combined with sanitary sewage and flowed to the sewage treatment plant.

Approximately 80 chemical compounds were generated or procured by this facility on an annual basis. Chemicals used in quantities exceeding 10 gallons per year included acids, amines, cyanide compounds, and both chlorinated and non-chlorinated solvents. Other materials used in Building 600 in smaller quantities included alkalis, alcohols, aldehydes, metals and metal compounds (including zinc, iron, cadmium, lead, and mercury), and asbestos. Analysis of the wastewater from Building 600 showed detections of amines, metals (i.e., cadmium, lead, zinc, copper, mercury, and silver), cyanides, nitrate esters, trichloroethylene, and methylene chloride. Mercury, zinc, and silver were also found to be present in low concentrations.

Site 49 – Chemical Disposal Pit

The Chemical Disposal Pit is designated as Site 49. The site consists of a circular concrete pit, approximately 2.5 feet in diameter and 3 feet deep, northwest of Building 444. The pit was designed to dispose of laboratory containers without exposing personnel to the contents. To dispose of laboratory waste in laboratory containers, the containers were placed on a steel grate in the pit. A metal plate was dropped on the containers. The fragments of shattered glass were caught in a wire basket below the steel grate, and the contents of the containers collected in the bottom of the pit and drained from the pit via a drain line to the sanitary sewer system. Reportedly, the pit received limited use until the early 1970s, when the container crushing hardware was removed. The concrete pit was still structurally sound with no visible fractures before its removal in May 2001. Note that this Chemical Disposal Pit (Site 49) is different from the Old Waste Acid Pit (OWAP), Site 14 (NEESA, 1983; NEESA, 1992). The OWAP was approximately 15 feet to 20 feet deep with rocks placed on the bottom, and was reportedly filled with concrete in 1975 (NEESA, 1992).

According to the PA (NEESA, 1992), a drain line exited on the south side of the pit and connected the pit to the sanitary sewer Manhole 473, as shown on a Bureau of Yards and Docks drawing (Drawing Number 670,579) in that report; however, during a visual inspection of Site 49 in 1996, another drain line entering the pit from the north was discovered. This line was thought to connect to sanitary sewer Manhole 472, as shown on a Bureau of Yards and Docks drawing (Drawing Number 15,699, 1964), which was reviewed by NEESA during the 1992 PA.

Site 50 – Building 103 Crawl Space

Site 50 is the crawl space beneath Building 103, which is a small one-story building with a concrete block foundation, built in approximately 1902. Laboratory equipment containing mercury (nitrometers, pycnometers, talianis, and thermometers) was reportedly used in Building 103 at different times. . Spent mercury handling procedures at Building 103 and other buildings in the laboratory area that used mercury consisted of pouring spent mercury into "slop jars" and running tap water into the jar over a sink to remove sulfuric acid from the mercury. Spills often occurred while transferring the spent mercury from nitrometers, and slop jars often broke. In addition, mercury was inadvertently washed out of the jars.

In 1988, while replacing two sinks in Building 103, workers discovered that the sinks were connected to a single drain line, which discharged directly to the soil beneath the building rather than to the storm or sanitary sewer system. After the discovery, a 4-inch- diameter polyvinyl chloride pipe was installed from the sink drain line to Manhole A, which is west of Building 102. The quantity of solvents and mercury discharged to the soil from 1902 to 1985 is unknown.

The crawl space below Building 103 is divided by a central load-bearing wall, running approximately east-west. The ground in the northern part of the crawl space is relatively flat, and the southern section slopes to the southwest. The entrance to the crawl space is along the southern wall. The drain from the two sinks was located in the southwest corner of the northern section of the crawl space. A small ditch along the west wall of the southern section of the crawl space drains to a shallow depression in the southwest corner, forming a collection point for runoff. The area around Building 103 is similar to the ground surface in the crawl space. The topography at the northern end of the building is relatively flat, while the ground slopes to the south at the southern end of the building.

Site 53 – Mercury Contamination of the Sewage System

Site 53 consists of the sewer lines serving the laboratory research buildings in the Lab Area. The sewage system contains both the storm sewer lines and the sanitary sewer lines from several buildings. Between the early 1900s and the late 1960s, all sewage generated in the buildings was piped directly to Mattawoman Creek. Since the late 1960s, separate sanitary and storm sewer systems have served the Lab Area. The sanitary sewage from the Lab Area was sent to the Sewage Treatment Plant No. 2 beginning in the early 1970s, when it was constructed, until the early to mid 1980s. From the mid 1980s to the early 1990s, the sanitary sewage was rerouted to the upgraded Sewage Treatment Plant No. 1 and Sewage Treatment Plant No. 2 was closed. In the early 1990s, Buildings 103 and 502 were connected to the Industrial Wastewater Treatment Phase I System, which is designed to collect operations wastewater for analysis before discharge to Sewage Treatment Plant No. 1.

Laboratory workers reported that approximately a liter of mercury was lost per month down the sinks from Building 102. Over the 77-year period (1909—1986) that the Building 102 laboratory operated without mercury traps on the sinks, up to 28,000 pounds of mercury could have been discharged to the drain lines (NEESA, 1992). Additional quantities of mercury may have been disposed down the drain lines as the result of similar mercury handling and disposal practices at the other laboratory buildings within the Lab Area.

Since 1969, observation and recovery of mercury and follow-on response actions have been documented as follows:

Time Line of Event	Follow-on Action
In 1969, approximately 10 pounds of mercury were recovered from Manhole B, south of Building 103.	
In late 1988, performed a video survey and concluded that sewer lines "in the vicinity of the laboratory buildings" were found to be in poor condition and in need of repair or replacement (NEESA, 1992). The vitrified clay and terra-cotta pipes were either broken, cracked, sagging, separated, or in some cases, collapsed.	Initiated repair and lining; activities likely caused the mercury levels of up to 150 parts per million in to be found sanitary sewage sludge from the Sewage Treatment Plant No. 1 (NEESA, 1992).
In early 1989, approximately 1 pound of mercury was recovered from Manhole A, west of Building 102.	No visible mercury during inspection of other manholes in the vicinity and down-line of laboratory buildings. The sewer lines in the area of Building 102 were blocked with sandbags, and mercury traps were installed on the lines.
Mercury levels in the Sewage Treatment Plant No. 1 sludge dropped below 10 parts per million between 1993 and 1996, and have remained within allowable levels since.	
Approximately 0.5 ounce of elemental mercury was recovered from the pipe during the terracotta pipe repair in Building 103 circa 2007 and Building 600 in March 2009.[1]	

Site 54 – Building 101

Building 101 is a two-story brick building where mercury compounds were used in research and development. As noted in the PA report, in the mid-1980s an NSF-IH employee in Building 101 detected mercury droplets and an organic solvent odor in the basement office when solvents were discharged through the pipe system, suggesting a potential leaky drainage pipe. In January 1990, several droplets of mercury were discovered on the insulation of a steam pipe in the southeast corner room of the first floor in Building 101. When Base Safety Office personnel began removing the drop ceiling tiles, mercury vapors were detected in the breathing zone, but no visible signs of mercury on the ceiling tile tracks were observed. A 1918 blueprint showed four nitrometers in the room above where the mercury droplets were discovered. It was reported that the nitrometer bulbs would sometimes explode under pressure during sensitivity testing.

Site 55 – Building 102

Building 102 is located in the center of the Lab Area and was constructed in 1909. It was used as a laboratory for testing nitrocellulose by the nitrometer method. Other mercury-containing equipment, including pycnometers, talianis, vacuum stability testers , and thermometers, was used to determine the densities and sensitivity of propellants throughout the 80 years of laboratory operations in Building 102. On October 6, 1987, metallic mercury was discovered dripping from the ceiling onto the sink table top of the

[1] A phone conversation with Jim Humphreys of NSF-IH on 4/27/09 and Jim Humphrey's email dated 4/29/09.

coffee mess, in the northern end of the basement of Building 102. The source of the mercury was believed to be the equipment located on the first floor (NEESA, 1992).

Building 102 was abandoned in February 1989, and the water supply to Building 102 was terminated to help alleviate the high mercury levels found in the sanitary sewage sludge (NEESA, 1992). According to employee interviews, a major spill occurred upstairs in Building 102 in the early 1960s.

Other Buildings (Buildings 303, 304, 555, and 596)

Most of the structures in the Lab Area have been used as laboratories or for chemical storage at some time during their history. Accounts of various personnel currently or formerly employed in the laboratories have indicated that historical practices, such as disposing of unusable chemicals directly on the ground surface outside laboratory doors, may have led to surface soil contamination in the Lab Area.

Wetland Area

The Wetland Area is a small emergent wetland (less than 0.5 acre) with cattails, rushes, and several trees. The shape and size of the wetted area associated with the wetland changes depending on precipitation (and the subsequent saturation of the soil), condensate from nearby aboveground steam pipes, and leaking freshwater pipes that lie beneath this area. Groundwater is more than 40 feet bgs throughout the site (Ensafe/Allen & Hoshall, 1994) and, therefore, does not discharge to the wetland. Overflow from the wetland area drains into the storm drain system, which discharges to Mattawoman Creek near Site 41.

2.2.2 Site Characteristics

Geology and Hydrogeology

The information on the site geology and hydrogeology summarized below is taken from the Phase II report. The shallow geology at the site consists of fine- to medium-grained silty sand from ground surface to a depth of approximately 4 feet bgs. Below this interval, a dense clay layer was encountered that extended to a depth of approximately 40 feet.

No shallow water-bearing zone was encountered in any of the borings. The Phase II report described a sandstone marker bed at 41 feet bgs in a soil boring near the southeastern edge of Thames Road, northwest of Building 444; at a depth of 32 feet bgs in a boring located between Buildings 881 and 444; and at 35 feet bgs in a third boring approximately 60 feet south of the southeastern corner of Building 502. The marker bed is a unit of the Tertiary Brandywine Formation and marks the bottom of the Lowland Deposits. It is described as a medium- to fine-grained reddish to white quartz sandstone, moderately cemented and very hard, and impenetrable by split-spoon sampling. Blow counts averaged 40 blows per foot. The marker bed indicates the bottom of the Lowland Deposits, which further suggested that no shallow water-bearing zone should be expected. Test results from two Shelby Tube samples of the clay layer indicated hydraulic conductivities of 7.1×10^{-8} centimeters per second and 1×10^{-6} centimeters per second. The results of the cation exchange capacity and total organic carbon analyses also support the presence of the hard clay. The Phase II report mentioned that the clay layer extends from 4 to 40 feet bgs. During the RI, the lower limit of this clay layer was not encountered because soil borings were advanced to only depths of up to 16 feet bgs.

Because the shallow groundwater has not been encountered and it is not expected to be encountered at shallow depths at the site, no monitoring wells were installed during the site investigation (SI) or the RI. As a result, the shallow groundwater has not been identified as a pathway for transport or exposure.

Land Use

The Lab Area is located in the restricted area of NSF-IH. The buildings within the Lab Area are currently unoccupied or are used as offices and laboratories. Because of its location, the future use of the site will remain industrial.

2.3 Previous Investigations

This section summarizes previous environmental investigations and studies at NSF-IH that are relevant to the Lab Area.

2.3.1 Phase II Site Investigation

In 1992, an SI was conducted at Sites 39 through 50, 53, 54, and 55 in two phases as a follow-up to the PA. Phase I focused on Site 42 (Olsen Road Landfill). Phase II focused on the remainder of the sites. Based on the results of the SI, all the sites were recommended for further study. Sites 15 and 16 (Building 600 sewers and Buildings 103 and 502 sewers) have not been specifically investigated, although they are encompassed by Site 53.

2.3.2 Remedial Investigation

The objectives of the RI were:

- Characterize the nature, extent, and concentrations of site-related contaminants in surface soil, subsurface soil, manhole and wetland sediments, and surface water, and determine the rate of migration of site-related contaminants in the environment
- Remove the Chemical Disposal Pit at Site 49
- Identify actual or potential human or environmental receptors and potential contaminant migration pathways

Fieldwork for the Lab Area RI began on April 30, 2001 and concluded on May 25, 2001. The field investigation included surface soil sampling, subsurface pipe bedding soil sampling, sewer sediment sampling, wetlands surface water and sediment sampling, and removing the Chemical Disposal Pit. In most instances, where analytical samples were collected, a full suite of analyses was performed. The full suite comprised target compound list volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) (including polycyclic aromatic hydrocarbons [PAHs]), target analyte list (TAL) inorganics (i.e., metals and cyanide), and explosives [which included nitroglycerin, nitroguanadine, pentaerythritol tetranitrate, and perchlorate, in addition to the list of analytes included in EPA SW-846 Method 8330]. Figure 2-2 shows the RI surface soil, sediment, and dry sediment sampling locations. Figure 2-3 shows the RI subsurface soil and sewer sediment locations.

Summary of Contamination

Various constituents were detected throughout the Lab Area, the more prominent being nitrocellulose, arsenic, lead, and mercury, among other inorganics and SVOCs.

Nitrocellulose was not determined to be a risk and was not observed to occur in any particular spatial pattern, other than occurring at higher concentrations in the surface soil at the topographic low sides of Buildings 102, 103, 108A, and 502.

The highest concentrations and the largest number of detections of metals were encountered in samples collected around Buildings 102 and 103, and around other buildings in the eastern part of the Lab Area. This is likely the result of the storage and laboratory practices in these buildings and this portion of the site. Samples collected along the northwestern and northern portions of the site had among the lowest concentrations of metals, likely because of topography and laboratory density.

Arsenic, lead, and mercury were detected throughout the Lab Area in the subsurface soil. Hot spots were identified around Manholes A and 471. Likely transport mechanisms for these constituents are releases from leaking underground sewer pipes and/or manholes, as well as infiltration and leaching from surface spills to about 4 feet bgs.

Overall, the sewer sediment samples demonstrated elevated levels of mercury, with some correlation to subsurface soil samples associated with the manholes, suggesting that mercury contamination in the subsurface soil occurred as a result of deteriorated piping and manhole connections. Therefore, elevated levels above base-wide background were assumed to be site-related.

The emergent wetlands contained elevated levels of mercury, arsenic, lead, and some organics. The soil, sediment, and surface water analytical results were reviewed and used for screening against human health and ecological screening criteria.

The Chemical Disposal Pit was removed, and confirmatory surface soil samples just outside the perimeter of the excavation, as well as the subsurface soil sample just below the excavation, demonstrated that the constituent levels were within EPA’s acceptable risk ranges to human or ecological receptors. Because of the collocation of the Chemical Disposal Pit and the Old Waste Acid Pit (OWAP), data collected associated with the Chemical Disposal Pit were also considered representative of the OWAP, and results of this RI were considered sufficient to document closure of the OWAP as well.

Details on the nature and extent of contamination are presented in Sections 3.2 through 3.5 of the RI report.

Human Health Risk Assessment

The HHRA was conducted as part of the RI to evaluate the potential human health risks associated with the presence of site-related surface soil, subsurface soil, surface water, and sediment contamination at the Lab Area.

The HHRA evaluated the Lab Area using the following groupings of sites:

- ***Lab Area Underground Sewer Lines***, which consists of the subsurface soil and sewer sediment
- ***Lab Area Surface Soil and Wetland Area***, which consists of the surface soil, wetland area sediment, and wetland area surface water

Potential risks were calculated for the following receptors:

For the *Lab Area Underground Sewer Lines*:

- Current Land Use:
  - Other Workers - Incidental ingestion of, inhalation of, and dermal contact with subsurface soil; and incidental ingestion of and dermal contact with sediment
- Future Land Use:
  - Industrial Worker: incidental ingestion of, inhalation of, and dermal contact with subsurface soil (assumed to be moved to the surface) and sediment
  - Adult/Adolescent Trespasser/Visitor: incidental ingestion of, and dermal contact with, subsurface soil (assumed to be moved to the surface)
  - Construction Worker: incidental ingestion of, inhalation of, and dermal contact with subsurface soil
  - On-site Resident (adult and child): ingestion of, inhalation of, and dermal contact with subsurface soil (assumed to be moved to the surface)

For the *Lab Area Surface Soil and Emergent Wetland Area*:

- Current Land Use:
  - Industrial Worker: incidental ingestion of, inhalation of, and dermal contact with surface soil
  - Adult/Adolescent Trespasser: incidental ingestion of, inhalation of, and dermal contact with surface soil
  - Other Recreational Person Adult/Child: incidental ingestion of and dermal contact with surface water and sediment

- Future Land Use:
  - Construction Worker: incidental ingestion of, inhalation of, and dermal contact with surface soil
  - On-site Resident (adult and child): incidental ingestion of, inhalation of, and dermal contact with surface soil

VOCs, SVOCs, and explosive compounds were found to be within EPA's acceptable risk ranges to human receptors, either because the concentrations were lower than criteria or because an exposure point, and/or the absence of a pathway or route of exposure were absent.

No carcinogenic risks were calculated outside EPA's acceptable risk range. Surface soil, subsurface soil, and emergent wetlands sediment were the only media that had noncarcinogenic hazards greater than the EPA target risk levels. The main risk drivers for these media were mercury (by incidental ingestion and inhalation) in surface and subsurface soil, and arsenic (by dermal contact) in the emergent wetlands sediment. Site-wide lead levels did not demonstrate a human health risk for lead; however, lead was identified as a localized potential health concern for the residential and industrial land use scenarios near Buildings 102, 103 and 304.

All of the non-carcinogenic risks noted above were a result of the standard reasonable maximum exposure evaluation in the HHRA; however, the subsequent central tendency analysis in the HHRA revealed no risks for any media.

Details of the HHRA are presented in Section 5.0 of the RI report.

Screening-Level Ecological Risk Assessment

The SERA for the Lab Area identified a potential unacceptable ecological risk for direct exposure to copper, lead, mercury, zinc, and some organics in soil; aluminum, copper, cyanide, iron, lead, manganese, and mercury in emergent wetland surface water; and an ecological risk for direct exposure to arsenic, lead, manganese, mercury, and silver in emergent wetland sediment. Also, lead, mercury, and zinc all appeared to exhibit risk in the food chain for the American robin, white-footed mouse, and/or raccoon.

Inorganics in soil and sediment (particularly mercury), posed potential risks to soil invertebrates, sediment invertebrates, and upper trophic level receptors that have substantial direct contact with soils or consume prey that have direct contact with soils. Food chain modeling also suggested that lead and zinc may pose risks through the food chain. Because of the high concentrations of mercury at the site, verification of the concentration of mercury in prey items is important for the top predators (e.g., red-tailed hawk), even though food chain modeling showed minimal risk to this type of receptor.

On October 23, 2003, the Indian Head Installation Restoration Team (IHIRT) and the Biological Technical Assistance Group (BTAG) agreed on a path forward for addressing the potential ecological risks at the Lab Area:

- Conduct future removal of the affected media in the emergent wetland and restore the wetland. The removal Preliminary Remediation Goals (PRGs) will be based on literature-based PRGs to be approved by BTAG. Potential risks to wetland receptors (i.e., water column invertebrates, amphibians, and omnivorous wetland mammals) will be removed once the wetland is restored. Therefore, further evaluation to refine the risk estimates associated with sediment COCs will not be conducted as part of the additional risk assessment work.

- Conduct a BERA on the surrounding Lab Area surface soil, to (1) confirm with a greater level of certainty the risk posed by COCs, (2) more accurately define the spatial area over which those risks are present, and (3) support development of PRGs for possible subsequent soil removal if unacceptable risks are identified at the conclusion of the BERA.

Details of the HHRA are presented in Section 6.0 of the RI report.

2.3.3 Baseline Ecological Risk Assessment

The results of the SERA revealed that several metals, polycyclic aromatic hydrocarbons (PAHs), and SVOCs posed potential risks to various biota, and that a BERA was warranted. In support of the BERA, surface soil samples were collected from 10 locations at the Lab Area and from one reference location (known to be free of contamination) southwest of the Lab Area, on May 23 and 24, 2005. The soil samples were analyzed for TAL metals, methylmercury, PAHs, SVOCs, pH, total organic carbon, and grain size (by sieve analysis). To evaluate direct toxicity to soil invertebrates, laboratory toxicity tests with the earthworm *E. foetida* were conducted on split samples from the soil sampling locations.

To characterize more accurately the potential risk to birds and mammals that might consume soil invertebrates from the Lab Area, the test earthworms were analyzed for TAL metals and methylmercury at the conclusion of the soil toxicity tests. The concentrations of metal constituents of potential concern (COPCs) (lead, mercury, and zinc) in the tissue samples were used to estimate exposure to insectivorous birds and omnivorous mammals.

The results of the soil invertebrate toxicity tests indicate that soil invertebrate survival is not affected at the Lab Area. Significantly reduced growth was observed in nine samples (eight sample locations plus one duplicate). Methylmercury was identified as possibly contributing to reduced growth in soil invertebrates at the Lab Area. However, the level of effect is unlikely to impair the soil invertebrate community. The observed decrease in growth was less than 20 percent at all locations, except one in comparison to the reference sample. In general, a reduction of less than 20 percent in the measurement endpoint is considered protective of the assessment endpoint.

The results of the earthworm tissue analyses and exposure calculations for insectivorous terrestrial birds and omnivorous terrestrial mammals indicate that the risks to these receptors from COPCs in surface soils at the site are within acceptable screening levels. The results of the BERA indicate that the COPCs identified in the RI report for the Lab Area do not pose unacceptable risks, so further investigation is not required.

Further details of the BERA are presented in the final BERA report (CH2M HILL, 2006).

2.3.4 Wetland Delineation

During the RI, the approximate limits of the wetland in the Lab Area were based on field observations of the wetted conditions of the area, soil type, and vegetation. Section 1.3.3 of the RI report discusses the variability in the shape and size of the emergent wetland, including its dependence on leaking freshwater pipes that lie beneath the area. These pipes were repaired after the RI report was completed. A wetland delineation was performed in April 2006 (see Appendix A), which estimated the boundary of the wetland by observing that the outer area of the previous estimation no longer met all three criteria (vegetation, hydrology, and hydric soils) to be defined as a wetland. The new delineation is shown in Figure 2-4. The boundary of the new delineation corresponds more accurately to the locations of the wetland samples classified as either surface soil or wetland sediment.

2.4 Extent of Contaminants of Concern

The HHRA, SERA, and BERA identified the following constituents as the COCs to be addressed in this FFS:

- Upland Area – Mercury and lead in surface soil, and mercury in subsurface soil
- Wetland Area - Arsenic and mercury in sediment

The following discussion summarizes the nature and extent of the COCs based on the RI data.

2.4.1 Mercury

Surface Soil

Mercury was detected in 76 out of 81 surface soil and dry sediment samples in the Lab Area. Concentrations ranged from 0.12 milligram per kilogram (mg/kg) to 962 mg/kg. The sample mean concentration of 52.40 mg/kg was three orders of magnitude greater than the base-wide background mean of 0.05 mg/kg, and every detected sample concentration exceeded the base-wide background 95-percent upper confidence limit (UCL) of 0.06 mg/kg. The concentrations of mercury in the upslope site-specific background samples IS53SS77 and IS53SS78 were 0.13 mg/kg and 0.51 mg/kg, respectively, above the base-wide 95-percent UCL. Naturally occurring mercury is present in soils in the eastern United States at levels as high as 3.4 mg/kg and in soils in Maryland at levels as high as 0.14 mg/kg (CH2M HILL, 2004).

Figure 2-5 (from Figure 3-5 of the RI) presents the concentrations of mercury in the surface soil, sediment, and dry sediment samples throughout the Lab Area. Mercury was detected in the surface soil around Buildings 101, 102, 102, 108, 108A, 304, 556, and 600, as well as in the emergent wetland, where the maximum mercury concentration of 962 mg/kg was detected (in dry sediment sample IS53SD18).

Ten surface soil samples (IS53SS01, IS53SS02, IS53SS03, IS53SS32, IS53SS48, IS53SS49, IS53SS64, IS53SS74, IS53SS75, and IS53SD18) had mercury concentrations above 100 mg/kg. These high concentrations were obtained throughout the site, around Buildings 102, 103, 444, and 600, as well as in the emergent wetland area. Historical use of mercury in these buildings is well known. The likely sources of mercury detections in the Lab Area would be physical dumping of mercury for disposal; the storage, accidental breakage of lab equipment containing mercury, and disposal (through leaky pipes) of mercury for various laboratory experiments and instruments (e.g., nitrometers, pycnometers, talianis, and thermometers); and the testing, production, and storage of explosives.

Subsurface Soil and Sewer Sediment Samples

Mercury was detected in 16 of the 28 subsurface soil samples and all 8 of the sewer sediment samples (Figure 2-6 – from Figure 3-9 of the RI). Concentrations in the subsurface soil ranged from 0.16 mg/kg to 362 mg/kg, and concentrations in the sewer sediment ranged from 0.34 mg/kg to 1,290 mg/kg. The maximum mercury concentration of 362 mg/kg in the subsurface soil was located beside Manhole 471, servicing Buildings 102, 103, and 303. The subsurface soil sample mean concentration was 15.56 mg/kg, which is three orders of magnitude greater than the base-wide background mean of 0.06 mg/kg. Additionally, 14 of the mercury-detected subsurface soil samples had concentrations greater than the base-wide background 95 percent UCL of 0.18 mg/kg. The maximum mercury concentration occurred in sewer sediment sample IS53SD04 (from Manhole 471) at 1,290 mg/kg. The sample mean concentration of the sewer sediment was 265.53 mg/kg, but no background data were available for comparison.

Mercury concentrations in the subsurface soil averaged higher than base-wide background, as well as the range of naturally occurring mercury in soils in the eastern United States (0.01 mg/kg to 3.4 mg/kg) and in Maryland (0.04 mg/kg to 0.14 mg/kg). Many of the sewer sediment samples contained higher concentrations of mercury than the subsurface soil samples, and some correlation was evident between sewer sediment and subsurface soil samples. In particular, Manhole 471 (directly downstream of Manhole A) contained a high concentration of mercury (1,290 mg/kg in sample IS53SD04), correlating with a high concentration in the associated subsurface soil sample IS53SB13 (362 mg/kg). Similarly, the sediment mercury concentration in Manhole A (547 mg/kg in sample IS53SD05) correlated with associated subsurface soil sample IS53SB10 (32.4 mg/kg).

Overall, every sediment sample demonstrated elevated levels of mercury was observed immediately outside the sewers or manholes suggesting that mercury contamination in the subsurface soil occurred because of deteriorated piping and manhole connections. This correlation supports the SI conclusion that if contamination, particularly mercury, had entered the soil system via the sewer lines, the extent of contamination would be limited to the soil in contact with joints and/or fractures in the pipes by the natural soil properties. No mercury pools were observed in the subsurface soils or the manholes during the RI field activities.

Sediment

Mercury was detected in two wetland sediment samples (Figure 2-5). The sample concentrations were 18.6 mg/kg and 24.5 mg/kg, with a sample mean concentration at 21.55 mg/kg, which is three orders of magnitude greater than the base-wide background mean of 0.07 mg/kg. Both sample concentrations exceeded the base-wide background 95 percent UCL of 0.2 mg/kg. No spatial trend could be discerned from the sediment samples data because of the limited number of samples.

Mercury concentrations in the emergent wetland averaged 21.55 mg/kg, whereas the surface soil concentrations averaged 52.40 mg/kg in the Lab Area. Both sample mean concentrations exceeded the range of naturally occurring mercury in Maryland (0.04 mg/kg to 0.14 mg/kg), suggesting that mercury contamination in the emergent wetland may be the result of activities specific to the Lab Area. This is a reasonable assumption, considering that the emergent wetland is a topographical collection point for surface water runoff that may contain mercury, as well as other contaminants at the Lab Area, and that mercury was historically used, disposed of, and released in the Lab Area. It is assumed that the mercury deposited in the emergent wetland resulted mainly from surface water runoff and soil erosion throughout the Lab Area, as well as undocumented dumping.

2.4.2 Arsenic in Emergent Wetland Sediment

Arsenic was detected in both emergent wetland sediment samples, at concentrations of 3.9 mg/kg and 20.2 mg/kg. Both sample concentrations were above the base-wide background mean of 3.3 mg/kg. The maximum concentration of 20.2 mg/kg (in sample IS53SD14) also exceeded the facility-wide background 95 percent UCL of 10.6 mg/kg. No spatial trend could be observed in the data generated from the sediment samples because of the limited number of samples, even when including the dry sediment samples. These sediment concentrations do not differ greatly from the surface soil sample concentrations (the surface soil arsenic sample mean concentration was 10.95 mg/kg, and the freshwater sediment sample mean concentration was 12.05 mg/kg). Arsenic naturally occurs in soils in Maryland (1.1 mg/kg to 7.1 mg/kg) and the eastern United States (0.1 mg/kg to 73 mg/kg) (CH2M HILL, 2004). Although arsenic values in the sediment fall within these ranges, it is still possible that these levels of arsenic in the emergent wetland sediment are due to site-related activities, specifically the historical application of herbicides and possibly pesticides. Figure 2-7 shows the arsenic concentrations in the emergent wetland sediment.

2.4.3 Lead in Surface Soil

Naturally occurring lead is present in soils in the eastern United States at levels as high as 300 mg/kg and in Maryland at levels as high as 50 mg/kg (CH2M HILL, 2004). Lead was detected in all surface soil and dry sediment samples at concentrations ranging from 4.5 mg/kg to 31,200 mg/kg. The mean lead sample concentration of 987.36 mg/kg was more than 50 times the base-wide background average of 17.9 mg/kg. Seventy-five of the 82 samples (91 percent) contained concentrations exceeding the background 95-percent UCL of 21.7 mg/kg. Additionally, 10 samples (IS53SS01, IS53SS02, IS53SS03, IS53SS04, IS53SS11, IS53SS12, IS53SS25, IS53SS26, IS53SS33, and IS53SS57) contained lead concentrations exceeding 1,000 mg/kg.

Figure 2-8 (from Figure 3-4 of the RI) presents the concentrations of lead in the surface soil and dry sediment samples throughout the Lab Area. Lead concentrations above 1,000 mg/kg are boxed to focus the discussion. Except for sample IS53SS57 (on the southern side of Building 303), the highest lead concentrations were obtained from the northeastern portion of the Lab Area, directly adjacent to Buildings 102, 103, 108, and 304, where the soil is likely to have been affected by lead paint. Samples IS53SS26 (on the southern side of Building 302) and IS53SS57 (on the southern side of Building 303) had especially high concentrations—at 31,200mg/kg and 14,100 mg/kg, respectively. Still, elevated levels of lead may be seen across the site. The concentrations of lead in the upslope site-specific background samples IS53SS77 and IS53SS78 were 8.3 mg/kg and 337 mg/kg, respectively. The elevated lead concentration in IS53SS78 may be because of its location slightly downslope of Building 108A.

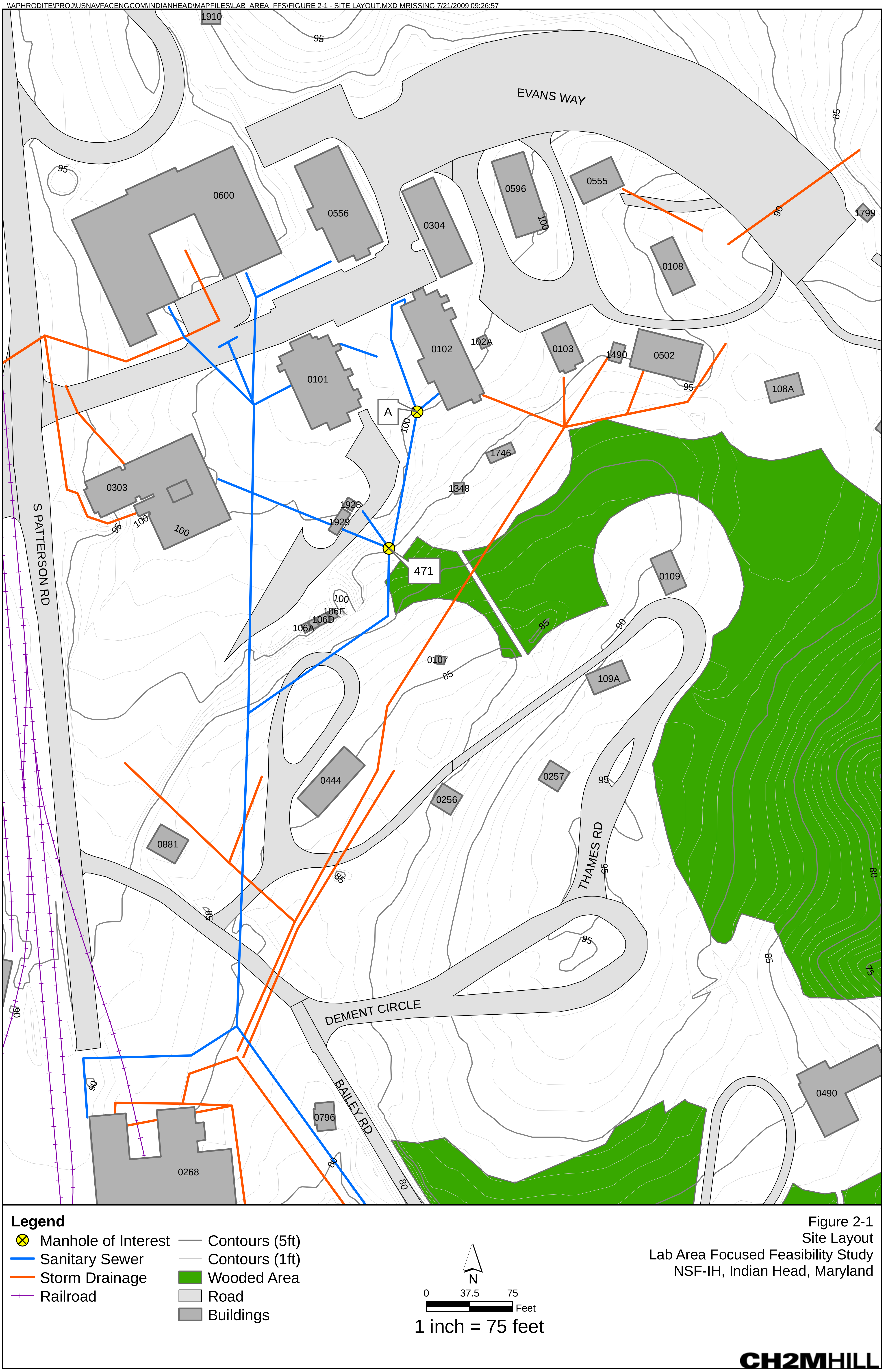

Figure 2-1
Site Layout
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL

Legend
- Dry Sediment Sample Location
- Sediment Sample Location
- Surface Soil Sample Location
- Sanitary Sewer
- Storm Drainage
- Railroad
- Contours (5ft)
- Contours (1ft)
- Wooded Area
- Road
- Buildings

0 37.5 75 Feet

1 inch = 75 feet

Figure 2-2
RI Surface Soil, Sediment, and Dry Sediment Sample Locations
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL

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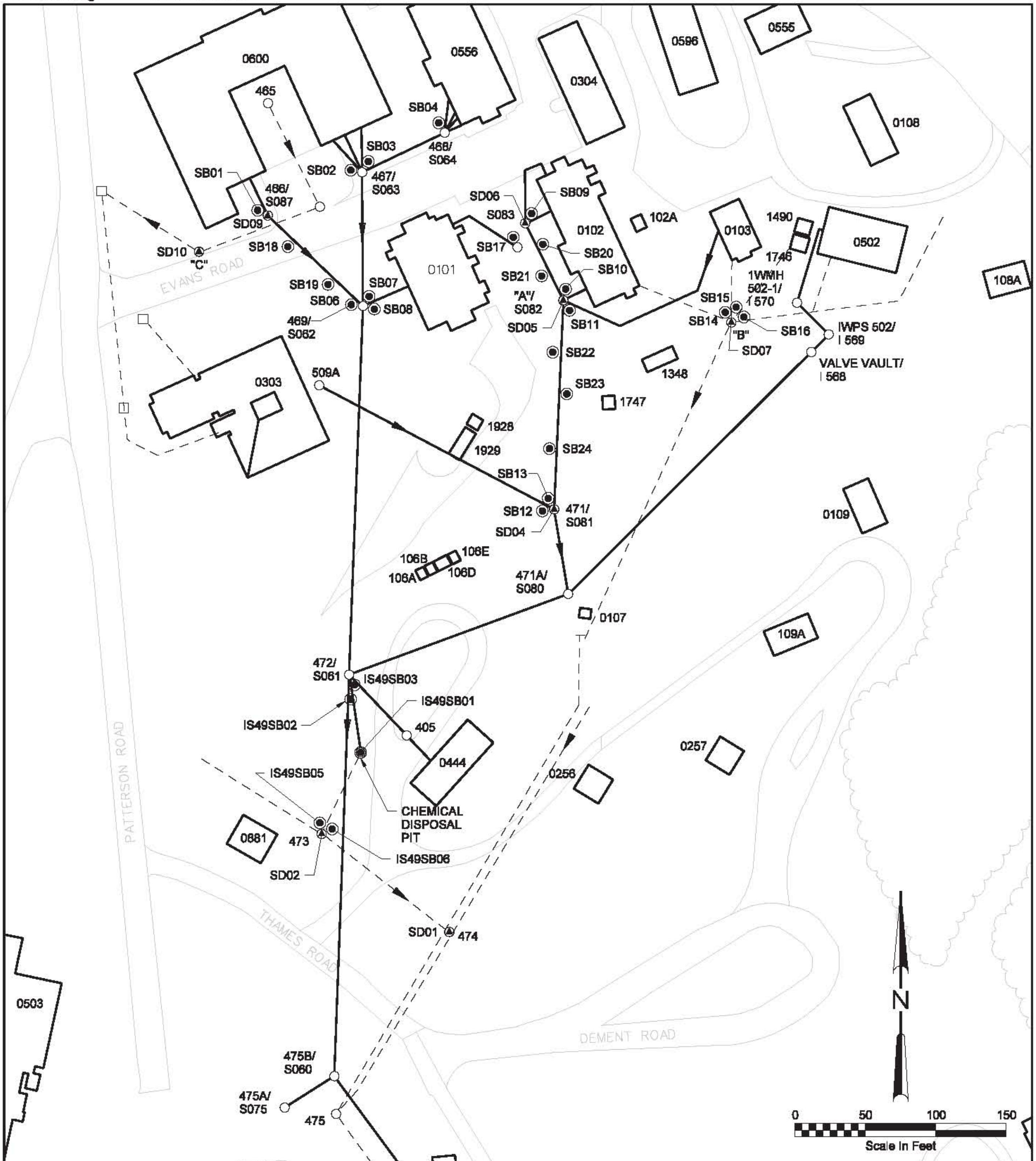

LEGEND

▲	SEDIMENT SAMPLE LOCATION
◉	SUBSURFACE SOIL SAMPLE LOCATION
○	MANHOLE
□	GRATE
- - -	STORM SEWER
———	SANITARY SEWER

Figure 2-3
RI Subsurface Soil and
Sewer Sediment Sample Locations
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

INDIAN HEAD, MARYLAND
CH2MHILL

\\APHRODITE\PROJ\USNAVFACENGCOM\INDIANHEAD\MAPFILES\LAB_AREA_FFS\FIGURE 2-4 - EMERGING WETLAND EXTENT.MXD 6/26/2009 12:02:14

Legend

- Manhole of Interest
- Sanitary Sewer
- Storm Drainage
- Railroad
- Contours (5ft)
- Contours (1ft)
- RI Wetland Extent (2004)
- Wetland Extent (2006)
- Wooded Area
- Road
- Buildings

N

0 37.5 75 Feet

1 inch = 75 feet

Figure 2-4
Emerging Wetland Extent
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL

\\APHRODITE\PROJ\USNAVFACENGCOM\INDIANHEAD\MAPFILES\LAB_AREA_FFS\FIGURE 2-5 - MERCURY CONCENTRATIONS IN SS SD AND DRY SD.MXD MRISSING

Legend

- Dry Sediment Sample Location
- Sediment Sample Location
- Surface Soil Sample Location
- Sanitary Sewer
- Storm Drainage
- Railroad
- Contours (5ft)
- Contours (1ft)
- RI Wetland Extent (2004)
- Wetland Extent (2006)
- Wooded Area
- Road
- Buildings

N

0 37.5 75 Feet

1 inch = 75 feet

Figure 2-5
Mercury Concentrations in Surface Soil, Sediment, and Dry Sediment
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL

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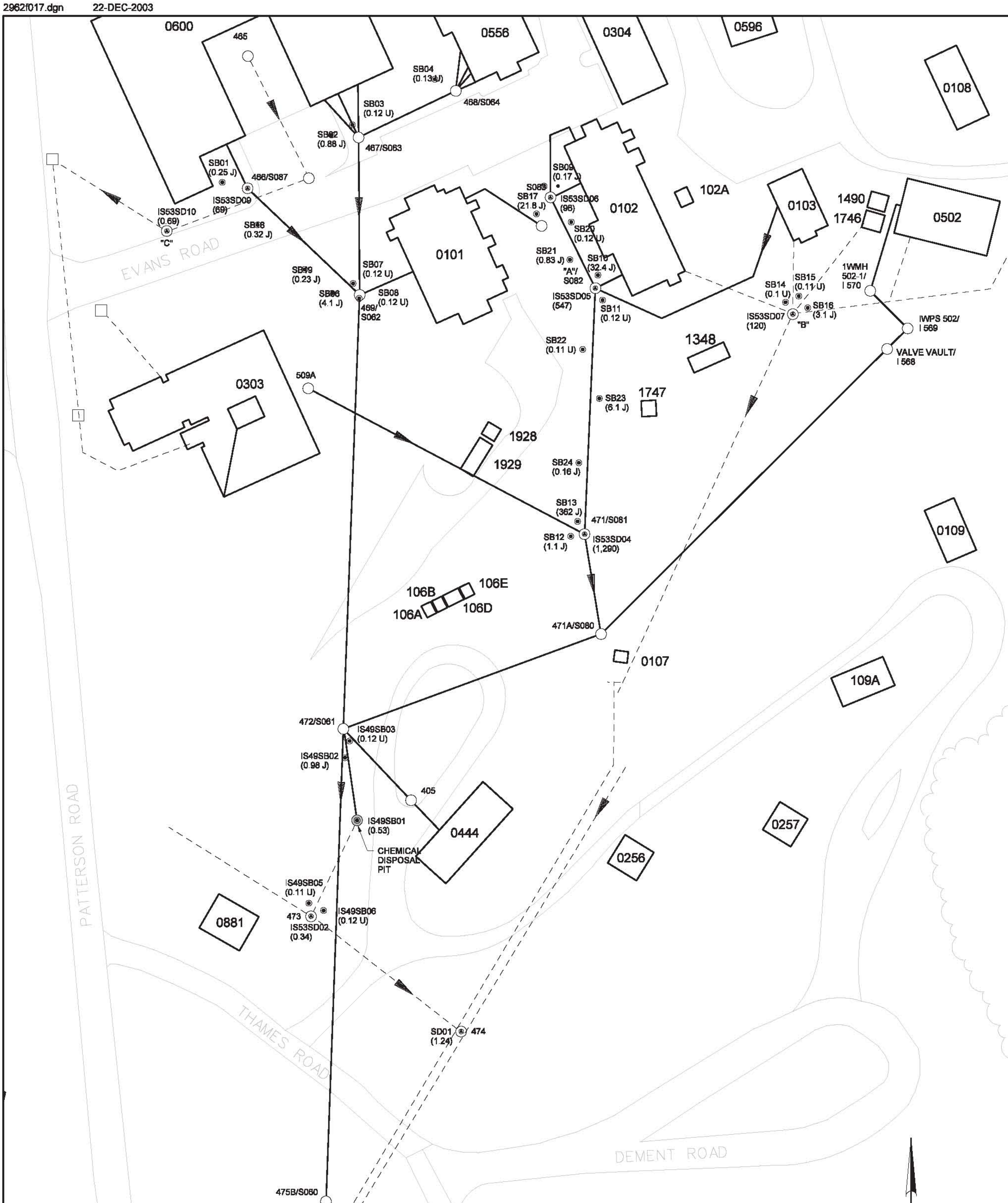


LEGEND:

- SEDIMENT SAMPLE LOCATION
- SUBSURFACE SOIL SAMPLE LOCATION
- MANHOLE
- GRATE
- STORM SEWER
- SANITARY SEWER
- (0.34) MERCURY CONCENTRATION IN MG/KG

U = NOT DETECTED
J = ESTIMATED VALUE
UJ = NOT DETECTED, QUANTITATION LIMIT MAY BE INACCURATE

ALL CONCENTRATIONS IN MG/ KG

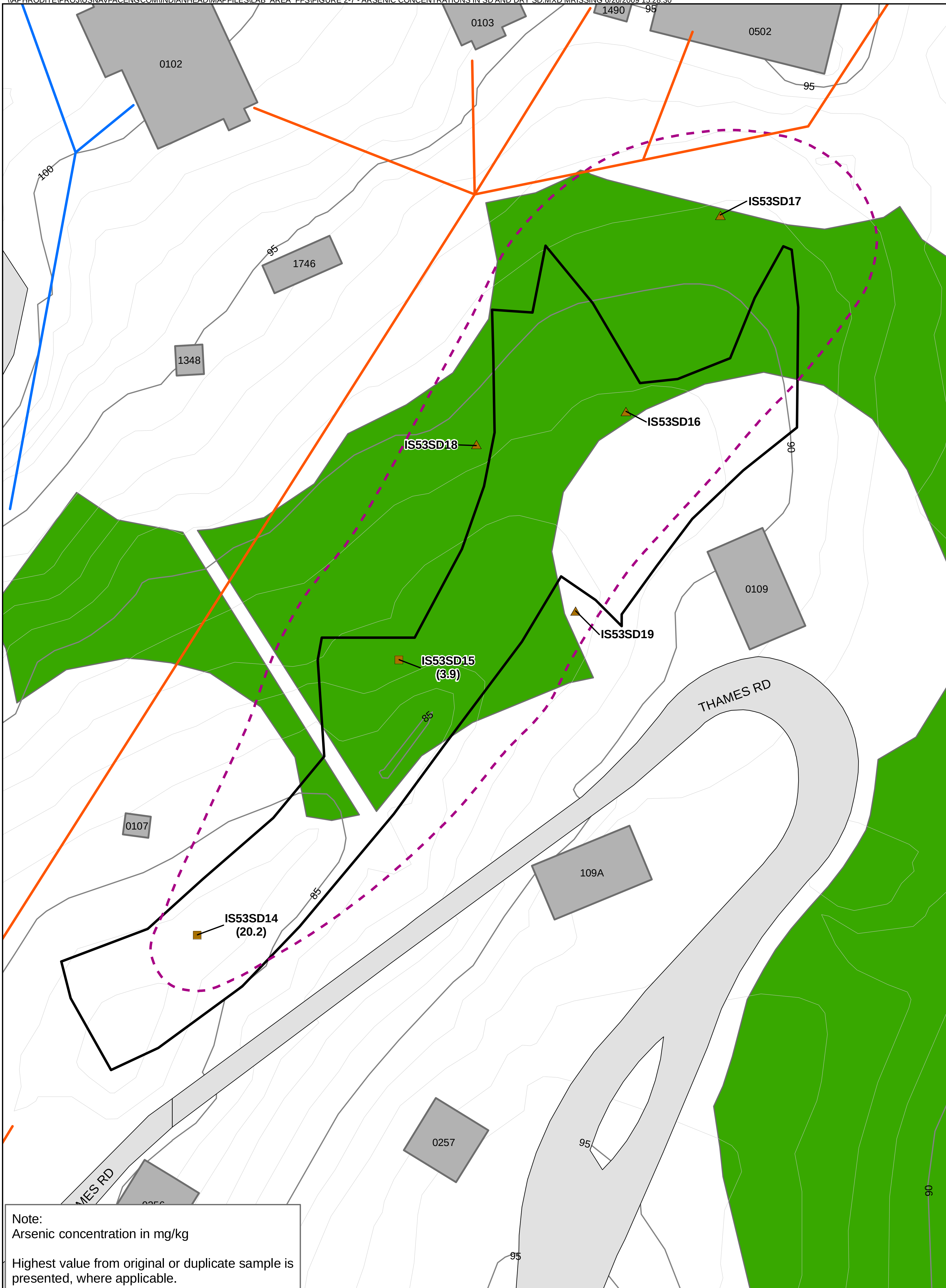
HIGHEST VALUE FROM ORIGINAL SAMPLE OR DUPLICATE SAMPLE IS PRESENTED, WHERE APPLICABLE.

SUBSURFACE SOIL BASE-WIDE BACKGROUND 95% UCL = 0.18 MG/KG
SUBSURFACE SOIL BASE-WIDE BACKGROUND MEAN CONCENTRATION = 0.06 MG/KG

LAB AREA SUBSURFACE SOIL MEAN CONCENTRATION = 15.56 MG/KG
LAB AREA SEWER SEDIMENT MEAN CONCENTRATION = 1,290 MG/KG

Figure 2-6
Mercury Concentrations in Subsurface Soil and Sewer Sediment
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL



Note:
Arsenic concentration in mg/kg

Highest value from original or duplicate sample is presented, where applicable.

Legend

- Dry Sediment Sample Location
- Sediment Sample Location
- Sanitary Sewer
- Storm Drainage
- Railroad
- Contours (5ft)
- Contours (1ft)
- RI Wetland Extent (2004)
- Wetland Extent (2006)
- Wooded Area
- Road
- Buildings

N

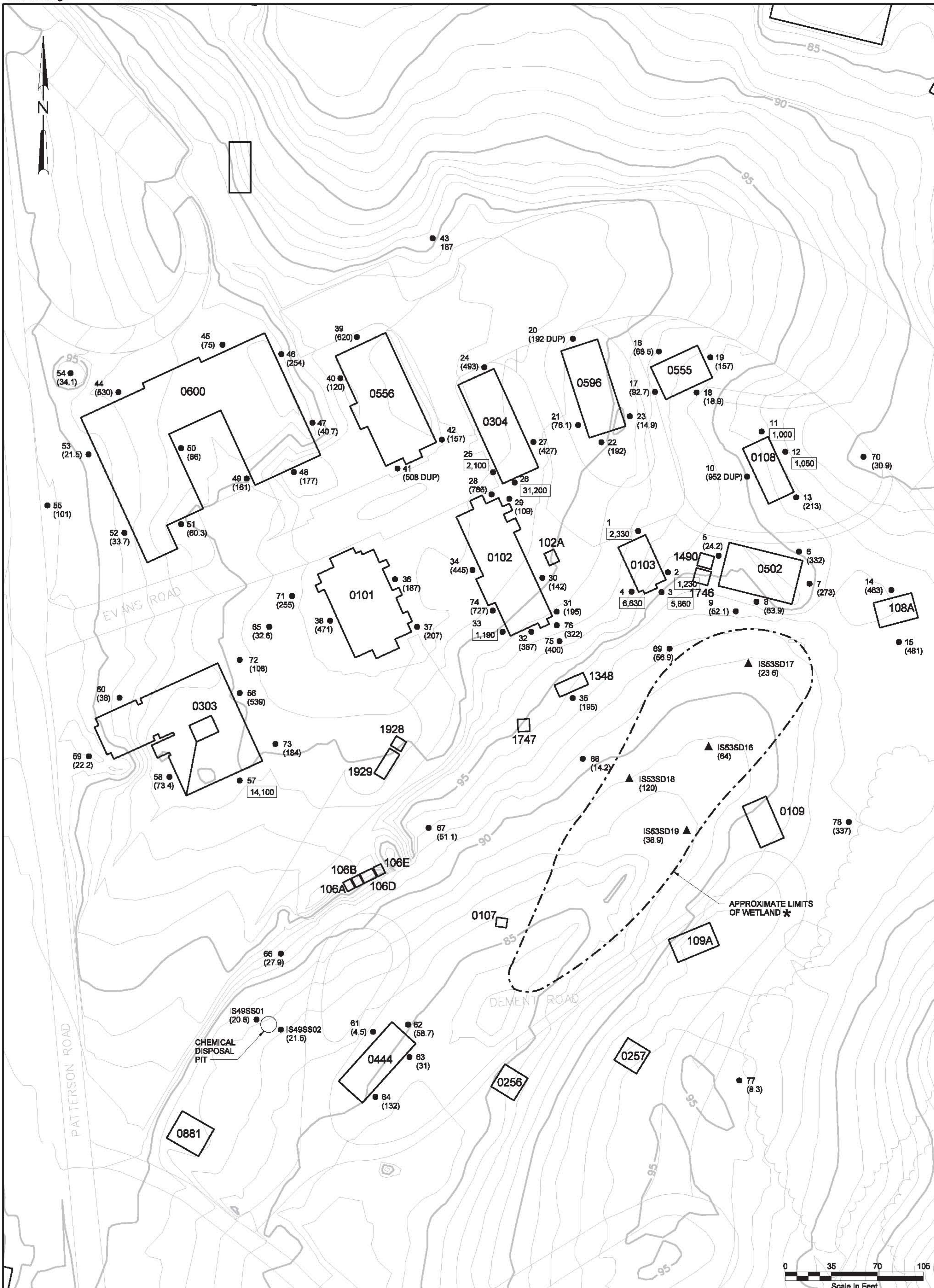
0 15 30 Feet

1 inch = 30 feet

Figure 2-7
Arsenic Concentrations in Sediment
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

CH2MHILL

2962f010.dgn 22-DEC-2003



LEGEND

- ● SURFACE SOIL SAMPLE LOCATION (TRUNCATED SAMPLE ID SHOWN FOR SITE 53 CONGLOMERATE SURFACE SOIL SAMPLES. NOTE SAMPLE ID FORMAT WOULD BE IS53SS##0001)
- ▲ DRY SEDIMENT SAMPLE LOCATION
- (13.4) LEAD CONCENTRATION IN MG/KG
- 14,100 SELECT HIGHER LEAD CONCENTRATION IN MG/KG (ABOVE 1,000 MG/KG)
- * ESTIMATED LOCATION OF EMERGENT WETLAND IN MARCH 2001. WETTED AREA CHANGES DEPENDING ON PRECIPITATION AND SATURATION, AS WELL AS THE PRESENCE OF UNDERGROUND LEAKING FRESHWATER PIPES (REFER TO SECTION 1.3.3).

NOTES:

HIGHEST VALUE FROM ORIGINAL OR DUPLICATE SAMPLE IS PRESENTED, WHERE APPLICABLE.

BASE-WIDE BACKGROUND 95% UCL = 21.7 MG/KG
BASE-WIDE BACKGROUND MEAN CONCENTRATION = 17.9 MG/KG

LAB AREA SURFACE SOIL MEAN CONCENTRATION = 987.36 MG/KG

Figure 2-8
Lead Concentrations in Surface Soil and Dry Sediment
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

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SECTION 3

Remedial Action Objectives, Applicable or Relevant and Appropriate Requirements, Site Remediation Goals, and Areas of Attainment

This section presents general and site-specific RAOs and identifies corresponding ARARs for the Lab Area. General RAOs are defined by the NCP (40 CFR 300.430 et seq.) and CERCLA (42 USC §§ 9601 et seq.), as amended by SARA.

CERCLA § 121(d) of SARA mandates that site remediation under CERCLA must achieve a level or standard of control for hazardous substances that at least attains such levels as specified in ARARs. Only promulgated federal and State of Maryland laws and regulations can be considered ARARs. In addition to ARARs, proposed rules, guidance documents, directives, and similar documents that might affect a CERCLA remedial action are "to-be-considered" (TBC) documents.

3.1 NCP Requirements

The NCP requires that the selected remedy meet the following objectives:

- Each remedial action selected shall be protective of human health and the environment [40 CFR 300.430 (f)(1)(ii)(A)].
- Onsite remedial actions that are selected must attain the ARARs identified when the ROD is signed [40 CFR 300.430(f)(1)(ii)(B)].
- Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in 40 CFR 300.430 (f)(1)(ii)(A) and (B). A remedy shall be cost-effective if its costs are proportional to its overall effectiveness [40 CFR 300.430 (f)(1)(ii)(D)].
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource-recovery technology to the maximum extent practicable [40 CFR 300.430(f)(1)(ii)(E)].

The statutory scope of CERCLA was amended by SARA to include the following general objectives for remedial action at all CERCLA sites:

- Remedial actions "…shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a minimum which assures protection of human health and the environment" [CERCLA Section 121(d)].
- Remedial actions "…in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" [CERCLA Section 121(b)] are preferred. If the treatment or

recovery technologies selected are not a permanent solution, an explanation must be published.

- The least-favored remedial actions are those that include “off-site transport and disposal of hazardous substances or contaminated materials without treatment where practicable treatment technologies are available” [Section 121(b)].
- The selected remedy must comply with or attain the level of any “standard, requirement, criteria, or limitation under any federal environmental law or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation” [Section 121(d)(2)(A)].

3.2 Site-Specific RAOs

Site-specific RAOs are based on the exposure setting for which protection would be provided (e.g., protection from ingestion, inhalation, or dermal contact with the contaminated media). The potential exposure routes and risks for the Lab Area and the Wetland Area were identified in the HHRA and SERA, presented in the RI report, and summarized in Section 2 of this FFS report.

Both the level of contamination and the potential exposure routes are considered when developing site-specific RAOs for protecting public health and the environment. The future protection of environmental resources and the means of minimizing long-term disruption to existing facility operations are also considered.

The site-specific RAOs for the Lab Area are:

1. Reduce risks to human receptors from exposure to mercury and lead in the surface soil in the Upland Area to acceptable levels under industrial use and residential use scenarios, respectively
2. Reduce risks to human receptors from exposure to mercury potentially present in and around sewer pipes in the Upland Area to acceptable levels under industrial land use scenario
3. Reduce risks to ecological receptors from exposures to mercury in the sediment in the Wetland Area to acceptable levels
4. Reduce risks to human receptors from exposure to arsenic in the sediment in the Wetland Area to acceptable levels

The RAs screened and evaluated for the FFS were selected with the objective of meeting the site-specific RAOs. The RAs must also meet the standards defined by ARARs of EPA and MDE. If the ARARs do not address a particular situation, remedial actions may be based on the TBC criteria or guidelines. ARARs and TBC criteria are described below.

3.3 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, remedial actions at the Lab Area carried out under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal and Maryland environmental laws and state facility-siting laws, unless waivers are obtained. According to EPA guidance, remedial actions also must be based on non-promulgated TBC criteria or guidelines if the ARARs do not address a particular situation.

EPA distinguishes ARARs as being either applicable to a situation or relevant and appropriate to a situation. The distinctions are critical to understanding the constraints imposed on RAs by environmental regulations. ARARs can include any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation. The definitions of ARARs below are from EPA guidance (EPA, 1988 and 1989). Both the applicable requirements and the relevant and appropriate requirements pertain to a site, to the extent practicable.

Applicable requirements are standards, standards of control, and other substantive environmental protection requirements, criteria, or limits promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, removal action, or other circumstance, as defined in the NCP, 40 CFR 300.5. For a requirement to be applicable, the remedial action or the circumstances at the site must satisfy all the jurisdictional prerequisites of that requirement. Only those state standards identified by a state in a timely manner and that are more stringent than federal requirements may be considered as applicable requirements.

Relevant and appropriate requirements are standards, standards of control, and other substantive environmental protection requirements, criteria, or limits promulgated under federal or state law that (although not applicable to a hazardous substance, a pollutant, a contaminant, a remedial action, or other circumstances at a CERCLA site) address problems or situations sufficiently similar to those encountered at the CERCLA site so that their use is well-suited to the particular site. Relevant and appropriate requirements also are defined in the NCP (40 CFR 300.5). For example, although Resource Conservation and Recovery Act (RCRA) regulations are not applicable to closing sites where in-place hazardous waste was disposed of before 1980, they may be deemed relevant and appropriate for landfill closure with in-place hazardous substances. Only those state standards identified by a state in a timely manner and that are more stringent than federal requirements may be considered as relevant and appropriate requirements.

In addition to ARARs, proposed rules, guidance documents, directives, and similar documents that might affect a CERCLA remedial action are TBC documents. If the ARARs do not address a particular situation, remedial actions should be based on the TBC criteria or guidelines.

Three classifications of requirements are defined by EPA in the ARAR determination process—chemical-specific, location-specific, and action-specific:

- *Chemical-specific* ARARs are health or risk-management-based numbers or methodologies that result in numerical values for a given media that would meet the NCP “threshold criterion” of overall protection of human health and the environment. These requirements generally set protective cleanup concentrations for the COCs in the designated media, or set safe concentrations of discharge for removal activity. Chemical-specific ARARs may be concentration-based cleanup goals or may provide the basis for calculating such levels. In cases where no chemical-specific ARAR exists, chemical advisories may be used to develop remedial objectives. Federal and state chemical-specific ARARs that may affect the development and conceptual arrangement of remedial action alternatives are summarized in Table B-1 of Appendix B.

- *Location-specific* ARARs restrict activities based on the geographic location of the site or characteristics of the surrounding environments. These ARARs are intended to limit activities within designated areas. Location-specific ARARs may include restrictions on actions within wetlands or floodplains, near locations of known endangered species, or on protected waterways. Federal and state location-specific ARARs that have been reviewed are summarized in Table B-2 of Appendix B.

- *Action-specific* ARARs are requirements that define acceptable procedures related specifically to the type of activity being performed. These ARARs control or restrict hazardous substance- or pollutant-related activities. These controls are considered when specific remedial activities are planned for a site. Federal and state action-specific ARARs that may affect the development and conceptual arrangement of RAs are summarized in Table B-3 of Appendix B.

3.4 Site Remediation Goals

This section presents a discussion of how the site remediation goals for the Lab Area are developed. The SRGs are determined based on the greater of site-specific, risk-based PRGs or facility-wide background concentrations. If the facility-wide background concentration was higher than the risk-based PRG, the background concentration was selected as the SRG. A risk-based PRG of 19 mg/kg was calculated for mercury in the Upland surface and subsurface soils based on a human health construction worker scenario, as industrial land use is the most likely scenario. In addition, a risk-based PRG of 400 mg/kg was calculated for lead in the Upland surface based on a human health residential land use scenario. The lead Integrated Exposure Uptake Biokinetic (IEUBK) Model used to calculate the PRG for the residential scenario is based on exposure to the lead at the site by a child, and evidence that indicates that very low exposure to lead can result in adverse health effects (neurological effects) to children (Appendix C). It is unlikely that children will be future residents at the Lab Area.

The PRGs for the two wetland COCs, mercury and arsenic, are 1.06 and 34 mg/kg, respectively. The mercury PRG is an ecological risk-based PRG which is a consensus-based probable effect concentration for freshwater sediments, and is protective of both the benthic community and semi-aquatic mammals, such as raccoons, that may forage in the wetland. The arsenic PRG is a human health risk-based PRG for future adult recreators.

Table 3-1 summarizes the selection of the proposed SRGs for use in the FFS. The detailed calculations and assumptions used in the calculation of the risk-based PRGs for mercury, arsenic, and lead are presented in Appendix C.

The SRGs were then used to identify which COCs will warrant a remedial action, by comparing the SRG of each COC to the maximum detected concentration. If the COC maximum detected concentration exceeds its SRG, a removal action is warranted for the

COC. Table 3-2 summarizes the process for identifying the COCs that will require remedial action.

Industrial land use is the most likely future land use for the Lab Area. Therefore, the use of the IEUBK model to calculate the PRG for lead based on a residential child is unrealistic for this site (Appendix C). The model used to predict a protective lead concentration for an industrial scenario is based on a pregnant (or soon to become pregnant) industrial worker. Therefore, ICs that would ensure pregnant workers are not working in areas know to contain average lead concentrations above the risk-based PRG would be protective for more realistic receptors and site use. The use of ICs may better address potential unacceptable risks, as opposed to excavating those areas which may only affect a few receptor populations.

The PRG calculations and values for the surface and subsurface soils are the same because the same exposure factors were used to calculate the PRGs for both soil horizons. It was assumed that in the future, the current subsurface soil could be redistributed during construction and be present at the surface. However, due to the extensive network of underground terra cotta pipes that will be left in place and the potential for residual mercury to remain in those pipes, future digging, and thus construction activities, will be limited. Therefore, institutional controls, instead of excavation, will be considered for the Upland subsurface soils.

3.5 Area of Attainment

The AA is defined as the area over which RAOs, and, therefore, the SRGs, are to be met. Figure 3-1 shows the AAs for the Lab Area, which encompass approximately 28,710 square feet (SF) of the Upland Area and 15,423 SF of emergent wetland. Three AAs are identified:

- Surface Soil AA: The surface soil AA has an area of 24,392 SF; its thickness was assumed to be 1 foot; the total volume is approximately 24,392 cubic feet (CF) or 902 cubic yards (CY)
- Subsurface Soil AA: The subsurface soil AA underlies the surface soil AA. Its area, however, cannot be easily estimated because it can be as large as the extent of the sewer pipe network, or it can have the same footprint as the surface soil AA. For the purpose of the FFS, this AA was assumed to be the same as the site boundary, with a thickness of 6 feet (i.e., an interval from 1 to 7 feet bgs). The bottom interval was assumed to represent the average depth of sewer pipe plus 1 foot of the soil bedding beneath the pipe. Based on this assumption, the volume of the subsurface soil AA is approximately 2,453,172 CF or 90,858 CY.
- Emergent Wetland Sediment AA: This AA is approximately 15,423 SF; its thickness was assumed to be 1 foot; the total volume was approximately 15,423 CF or 571 CY.

TABLE 3-1
Summary of Proposed SRGs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

COC	Medium	Facility-wide Background Concentration (mg/kg)[1,2]	Human Health Risk-Based PRGs (mg/kg)		Eco Risk-Based PRG (mg/kg)
			Residential	Industrial	
Mercury	Surface Soil	0.06	11[3]	**19**	NR
	Wetland Sediment	0.2	NR	NR	**1.06**
Arsenic	Wetland Sediment	10.6	**34**	NR	NR
Lead	Surface Soil	21.7	**400**	1,092	NR

Note:
NR – No Risk

Bold font indicates the proposed SRG

* - Subsurface soil present at the surface to be exposed to future receptors

1 The surface soil facility background concentrations were obtained from the *Background Soil Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Maryland* prepared by Tetratech NUS in February, 2002

2 The wetland sediment facility background concentration was obtained from the *Background Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Maryland* prepared by Brown and Root Environmental in December, 1997.

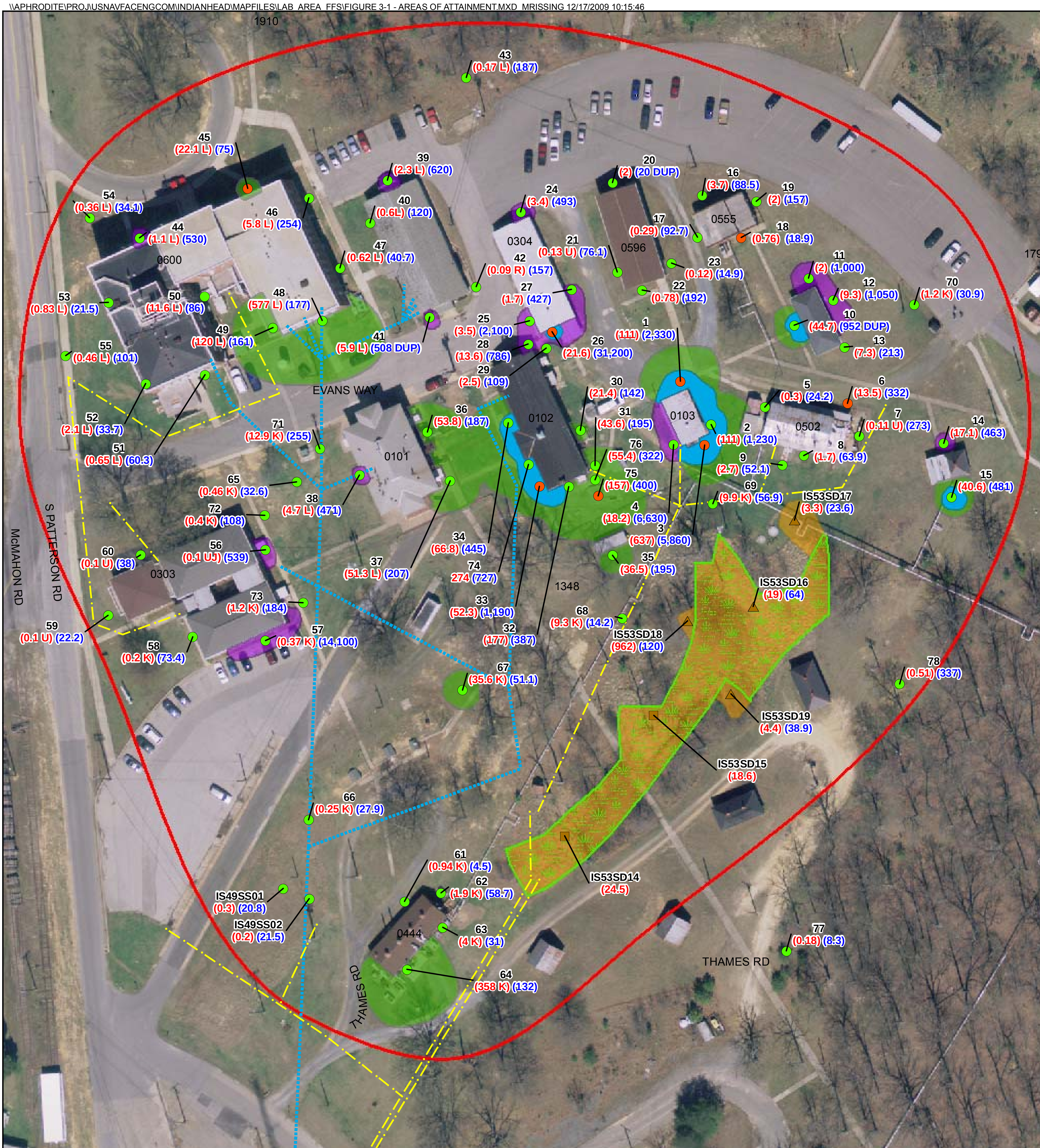
3 Representing the lowest value among the adult and child residents and the adult and child recreators.

TABLE 3-2
COCs Requiring Removal
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

COC	Medium	Max Detect	FOD	Facility Background	# of Background Exceedances	Proposed SRG	Basis	# of SRG Exceedances	Require Remediation?
Mercury	Surface Soil	962	76/81	0.06	76/81	19	Non-carcinogenic risk to construction workers, THI = 1	21/81	Yes
	Wetland Sediment	24.5	2/2	0.2	2/2	1.06	Probable effect concentration for freshwater sediments	2/2	Yes
Arsenic	Wetland Sediment	20.2	2/2	10.6	1/2	34	Carcinogenic risk to future adult recreator, TR = 10^{-4}	0/2	No
Lead	Surface Soil	31,200	82/82	21.7	75/82	400	Future child resident, IEUBK Model	23/82	Yes

Note: All concentrations are in mg/kg

\\APHRODITE\PROJ\USNAVFACENGCOM\INDIANHEAD\MAPFILES\LAB_AREA_FFS\FIGURE 3-1 - AREAS OF ATTAINMENT.MXD MRISSING 12/17/2009 10:15:46



Note:
Areas reported in square feet; individual surface soil AA for Hg and Pb includes the overlap area
Concentrations in mg/kg

L = Value may be biased low
U = Not detected above corresponding detection limit
R = Unreliable result
UJ = Not detected, quantitation limit may be inaccurate
K = value may be biased high

Highest value from original or duplicate sample is presented, where applicable.

Red values indicate mercury concentration
Blue values indicate lead concentration

0796

	Areas of Attainment (sq ft)
Surface Soil AA (≥ 19 mg/kg of Hg)	24,392
Surface Soil AA (≥400 mg/kg of Pb)	7,274
Overlap of AA based on Hg and Pb	2,955
Total Surface soil AA based on HG and Pb	28,710
Wetland AA (≥1.06 mg/kg of Hg)	15,423
Subsurface Soil AA	408,862

Legend

- Dry Sediment Sample Location
- Sediment Sample Location
- Surface Soil Sample Location
- Surface Soil Sample Location for BERA
- Storm Sewer
- Sanitary Sewer (Based on the 11/1/1991 Area Development Plan for Area 12 - Utilities, Sanitary Sewerage and Storm Drainage Systems)
- Approximate Lab Area Site Boundary
- Wetland Extent (2006)

N

0 37.5 75 150 Feet

Figure 3-1
Areas of Attainment
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

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SECTION 4

Identification and Screening of Remedial Technologies and Assembly of Remedial Alternatives

This section discusses the general response actions (GRAs) that were developed to address the RAOs outlined in the previous section. Potential remedial technologies and specific process options, which underwent a primary screening to evaluate their suitability as part of an RA, are identified and described for each response action.

4.1 General Response Actions

GRAs are broad classes of responses or remedies developed to meet the site-specific RAOs defined for the Lab Area surface and subsurface soil and emergent wetland sediment discussed in Section 2. Each action is intended to address specific constituents and the possible migration pathways and exposure routes in groundwater. Although an action may be capable of meeting an objective, combinations of actions may be more cost-effective in meeting all the objectives. Table 4-1 presents the GRAs and the preliminary screening of various technologies within each GRA.

The GRAs listed below have been identified as being potentially applicable for the NSF-IH Lab Area:

- No action
- ICs
- Removal and offsite disposal
- *Ex situ* treatment
- *In situ* treatment
- Containment

The no-action response is included in the study because the NCP requires that a no-action alternative be developed as a baseline for evaluating the RAs.

The ICs response action is a category of alternatives that can be used as one or as part of another response action. ICs include activities such as restricting land use through land-use or deed restrictions, access restrictions, and long-term monitoring.

Removal and offsite disposal response actions include actions taken to physically remove contaminated soil (surface soil, emergent wetland sediment and associated surface water) from the site and dispose of the material in an offsite permitted disposal facility.

Ex situ treatment response actions are methods of reducing the toxicity, mobility, or volume of contaminants. Treatment technologies in this category include solidification and stabilization, and chemical/acid extraction. Treated solids can be then placed onsite or at a permitted offsite facility.

In situ treatment response actions are in-place methods of reducing the toxicity, mobility, or volume of contaminants. For inorganic COCs at the Lab Area, this category is limited to using solidification and stabilization technologies.

Containment response actions are technologies that provide physical barriers to exposure to the contaminants. Technologies in this category include covering contaminated soil or sediment with clean soil or an impermeable cap.

4.2 Identification and Screening of Technologies and Process Options

The next step in the FFS process is to identify remedial technologies and process options for each GRA. Remedial technologies are general categories of technologies such as chemical treatment, thermal destruction, or immobilization. Process options are specific processes within each technology type. For example, the chemical treatment remedial technology includes process options such as precipitation, ion exchange, and oxidation/reduction.

Technologies and process options that potentially apply to the Lab Area soil and emergent wetland were qualitatively screened based on their effectiveness, implementability, and cost for achieving the RAOs.

The effectiveness criterion focused on the ability of a technology to reduce toxicity, mobility, or volume through treatment; minimize residual risks; afford long-term protection; comply with ARARs; minimize short-term impacts; and, achieve protection within a reasonable timeframe. The NCP instructs that "alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration" (40 CFR 300.430(e)(7)(i)).

The evaluation of implementability focuses on technical feasibility, availability, and administrative feasibility. Technical feasibility refers to the ability to build and reliably operate/maintain a technology. Administrative feasibility refers to the ability to gain approval from regulators and other agencies and to obtain the necessary materials and skilled labor. The NCP instructs that alternatives "that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration" (40 CFR 300.430(e)(7)(ii)).

The evaluation of cost addresses direct and indirect capital costs and annual operation and maintenance (O&M) costs. The cost range is presented quantitatively when possible. Otherwise, qualitative descriptions of low, moderate, and high cost are used. The costs are estimated from a review of the literature, vendor quotations, and data prepared for other studies. The NCP instructs "costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated" (40 CFR 300.430(e)(7)(iii)).

Table 4-1 presents the screening of the technologies and process options, as well as the rationale for why a technology or option was eliminated or retained for further considerations. The technologies and options that passed this initial screening are:

- No Action – The no-action response is required by the NCP and was retained to provide a basis for comparison with the other action.
- ICs – IC measures were retained because they can control, minimize, or prevent human exposures to the contaminated soil and sediment; they can be used on their own as an RA or coupled with other options to form an RA
- Excavation and offsite disposal – Although it does not involve any treatment component, this combination of options is retained because it would remove the contaminated media from the site, potentially eliminating the long-term requirements of monitoring or other periodic activities typically required if contaminated media are left in place.

4.3 Development of Remedial Alternatives

As described in Section 2.2.1 and shown in Figure 2-1, the sewer line network spans the entire Lab Area. A portion of the sewer network has existed since 1900s, and throughout its existence, it has been modified numerous times. As a result, its current footprint is almost unknown. Section 2.4.1 summarizes the sampling results from 28 subsurface soil locations and 8 sediment locations. The results indicated that the sediment from the manholes had mercury concentrations that were higher compared to samples collected from subsurface soil adjacent to the sewer manholes. Thus, it would appear that the mercury contamination in the subsurface soil is associated with the sewer pipe network. Since 1988, NSF-IH has mitigated mercury contamination in the sewer network through emergency pipe repairs; whereby, mercury is removed during these repairs. Because the extent of the sewer network is unknown, the current approach taken by NSH-IH in mitigating mercury is the most practical considering that the future land use of the Lab Area will likely remain industrial. Based on the above considerations, the IHIRT considered that the appropriate action for the subsurface soil AA would be continued implementation of ICs.

No remedial alternative was developed or evaluated for Sites 14 and 49 because of the NFA determination for these two sites.

For the remaining sites within the Lab Area, the following technologies and options have been assembled into RAs for the site, based on the strategy discussed above::

- Alternative 1: No Action
- Alternative 2: ICs
- Alternative 3: Excavation of Surface Soil and Emergent Wetland Sediment, Offsite Disposal, Site Restoration, and ICs

Each RA is described in detail in the next section.

TABLE 4-1
Screening of Technologies and Process Options
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

General Response Action	Removal Action or Technology	Process Options	Description	Effectiveness	Implementability	Relative Cost	Screening Action Retain	Screening Action Reject	Screening Comments
No Action	None	Not applicable	No action	Does not protect human health or the environment Does not satisfy RAOs	Easily implemented	Low	X		Retain as baseline alternative, as required by the NCP, against which all other alternatives are compared
Institutional controls	Access restrictions	Warning signs, fence	Placement of warning signs to prohibit certain activities	Effectiveness depends on continued future implementation regardless of property use or ownership.	Easily implemented on NSF-IH property	Low	X		Applicable, could be used with other remedial alternative(s) until RAOs are met
	Land use restrictions	Land use restrictions	Land use restrictions incorporated into the facility's planning documents	Does not reduce contaminant levels but effective in minimizing human exposures.					
Removal and Disposal	Excavation and Off-Site Disposal	Excavation and Off-Site Disposal	Removal of surface soil and emergent wetland using standard heavy equipment to an estimated depth of 1 foot below ground surface and disposal of waste at appropriate landfills off-site	Highly effective, waste and contaminated soil will be removed and disposed of at a permitted off-site landfill	Implementable	High to Very High capital, zero O&M	X		Technically feasible and applicable
	Excavation and On-Site Disposal	Excavation and On-Site Disposal	Removal of surface soil and emergent wetland using standard heavy equipment to an estimated depth of 1 foot below ground surface and disposal of waste at appropriate landfills on-site	Highly effective, waste and contaminated soil will be removed and disposed of at a permitted on-site landfill	Not implementable because NSF-IH does not have an on site disposal facility that is suitable to accept the material	Very high capital, extensive permitting process		X	Not feasible
Ex Situ Treatment (Assuming Excavation)	Physical/chemical treatment	Solidification / Stabilization	Remove surface soil and emergent wetland using standard heavy equipment, then chemical/physical treatment of soil and sediment off-site to remove contaminants, then replace soil and sediment	Potentially effective	Implementable	Extremely High capital, Low O&M		X	Technically feasible, but volume of waste too small to be economically and logistically feasible
	Physical/chemical treatment	Chemical Extraction	Uses an acid, such as hydrochloric acid (HCl), to extract heavy metal contaminants from soils. Soils are first screened to remove coarse solids. HCl is then introduced into the soil in the extraction unit. The residence time in the unit varies depending on the soil type and contaminants, but generally ranges between 10 and 40 minutes. The soil-extractant mixture is continuously pumped out of the mixing tank, and the soil and extractant are separated using hydrocyclones.	Potentially effective	Implementable but has a high safety risks to the remediation workers	Extremely High capital, Low O&M		X	Technically feasible, but volume of waste too small to be economically and logistically feasible
In situ treatment	Physical/chemical treatment	Stabilization	Chemically binds contaminants in place in a solidified matrix	Potentially effective	Implementable but not feasible because it will change and restrict the land use; the current activities of administrative office and laboratory cannot be performed at the site, the wetland will be converted into a grassy area	High to Very High capital, Low O&M		X	Infeasible
Containment	Capping	Permeable or impermeable cap	Cover the AAs with soil cover or impermeable cap	Potentially effective	Implementable but not feasible because it will change and restrict the land use; the current activities of administrative office and laboratory cannot be performed at the site, the wetland will be converted into a grassy area, and ICs has to enforce to maintain the integrity of the cap	High to Very High capital, Low O&M		X	Infeasible

SECTION 5

Description and Detailed Analysis of Remedial Alternatives

5.1 Descriptions of RAs

5.1.1 Alternative 1: No Action

The No-action alternative is required by the NCP and serves as the baseline alternative. All other RAs are judged against the no-action alternative. Under this alternative, no controls or remedial technologies will be implemented. CERCLA [Section 121(c)], as amended by SARA (1986), requires that the site be reviewed every 5 years because contamination would remain on site. However, in accordance to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000), costs associated with the 5-year reviews were not included in this alternative.

NSF-IH is an active Navy installation that has certain ICs in place, such as the access and land use restrictions.

5.1.2 Alternative 2: Institutional Controls

Alternative 2 will consist of placing ICs on the AAs described in Figure 3-1 and in Section 3.5. Such controls will help minimize the potential for human exposure to contamination by ensuring appropriate land use is maintained. The Upland Area AAs must prevent unlimited exposure because the levels of mercury and lead present in the surface soil exceed the SRGs for human health.

Detailed components of this alternative include:

- Designating the site as a "restricted use" area, which will prohibit intrusive activities such as excavation or residential development. The AA boundaries will be placed in the Base GIS system to indicate the boundaries of the ICs for the surface soil, the subsurface soil, and the emergent wetland sediment. The restricted use designation would remain in place as long as it is determined that the risk associated with the mercury contamination in the subsurface soil remain unacceptable. Placing signs warning persons of mercury and lead concentrations exceeding levels safe for human health.
- Maintaining a list of human receptors and associated activities that can result in unacceptable risks on file and integrate this into the comprehensive work approval permit (CWAP) system that is currently in place.
- Conducting biannual inspections of AAs to confirm that the land is being used appropriately according to the ICs.
- Conducting 5-year reviews to replace signs (if necessary), perform surface soil and sediment monitoring, and report on site conditions.

For cost estimating purposes, the implementation timeframe of this alternative is assumed to be 30 years. Within this timeframe, it is assumed that the surface soil and sediment monitoring for the COCs would be required every 5 years.

If Alternative 2 were to be selected for this site, the detailed components of the ICs would be prepared in a separate document after the ROD is signed.

5.1.3 Alternative 3: Excavation of Upland Area Surface Soil and Wetland Area Sediment, Offsite Disposal, Site Restoration, and ICs

Alternative 3 will consist of excavating surface soil and wetland sediment, restoring the surface soil and the wetland, providing offsite disposal of the excavated material, implementing ICs for the subsurface soil, and conducting a 5-year review.

Detailed components of this alternative include:

- Excavating the surface soil and emergent wetland sediment AAs as defined in Figure 3-1 and Section 3.5
- Conducting lateral post-excavation confirmatory sampling; vertical confirmation is not necessary as the depth of excavation is to 1 foot, which is beyond the impacted ecological zone from 0-6 inches. A detailed confirmatory or verification sampling plan will be prepared after the ROD is signed.
- Restoring the surface soil excavation area by backfilling the area with 6-inch layer of clean fill and 6-inch layer of top soil, followed by proper compaction and reseeding the area.
- Restoring the emergent wetland excavation area into a wetland; an approved combination of native wetland species will be planted, and the newly restored wetland will inspected quarterly for the first year until the plants are established, then twice a year for the second year, and once a year for the third through the fifth year.
- Improving and maintaining the best practices in surface water runoff management, such as reseeding bare spots to minimize uncontrolled runoff sources and maintaining the condition of the surface water runoff ditches or lines.
- Transporting and disposing of the excavated material to an offsite permitted facility.
- Implementing ICs on the subsurface soil AA (equivalent to the entire site boundary) by putting the boundary of the AA in the base GIS system and indicating that the sewer pipe network's integrity can be poor and may contain high concentrations of mercury; the requirements of ICs will be integrated into the CWAP system and made into one of the criteria in the CWAP approval for any future work at the site.
- Conduct 5-year reviews.

5.2 Evaluation Criteria

This section describes the screening criteria used in the detailed evaluation and the method for the comparative analysis of RAs.

Section 300.430(e) of the NCP lists nine criteria against which each RA must be assessed. The acceptability or performance of each alternative against the criteria is evaluated individually so that relative strengths and weaknesses may be identified. The detailed criteria are as follows:

Threshold Criteria

- Protection of human health and the environment
- Compliance with ARARs

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- State acceptance
- Community acceptance

The first two criteria are requirements that must be met unless specific ARARs are waived. The first seven criteria are addressed in this FFS report. The last two criteria will be addressed in the Proposed Plan and ROD. Figure 5-1 summarizes the NCP criteria.

The cost estimates presented in this FFS report only provide an accuracy of +50 percent to -30 percent. The estimates are in 2008 dollars and are based on conceptual design information available at the time of this study. The actual cost of the project would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between alternatives. The cost estimates were prepared in general conformance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA, 2000).

Expenditures that occur over different time periods are returned to present worth, which discounts all future costs to a common base year. Present-worth analysis allows the cost of the RAs to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include discount rates of 3.3percent for a 5-year and 4.5 percent for a 30-year or longer timeframe[2] (Office of Management and Budget, 2009), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years.

[2] Nominal discount rate on treasury notes and bonds from http://www.whitehouse.gov/omb/assets/omb/memoranda/fy2009/m09-07.pdf

5.3 Detailed Evaluation of RAs

This section analyzes in detail the RAs presented in Section 4.0. No remedial alternative was developed or evaluated for Sites 14 and 49 because of the NFA determination for these two sites.

For the remaining sites within the Lab Area, the RAs are discussed below:

5.3.1 Alternative 1—No Action

This No-action alternative is required by the NCP. Under this alternative, no further effort or resources would be expended at the Lab Area to address the surface soil or wetland sediment contamination. The No-action alternative serves as the baseline alternative against which the effectiveness of other alternatives are judged.

Overall Protection of Human Health and the Environment

This alternative does not contain measures to prevent potential future industrial or construction workers from disturbing or being exposed to contaminated soil. The human health risks posed by mercury- and lead-contaminated soil would not be decreased because the risk of potential future exposures would continue. Accordingly, the No-action alternative is not protective of human health and the environment.

Compliance with ARARs

There are no applicable chemical-, location- or action-specific ARARs because no remedial actions will be undertaken with this RA.

Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence. There would be no reduction in risk to human or ecological receptors under this alternative. Long-term and potential future risks posed by the site are described in the RI risk assessments.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative does not include treatment.

Short-Term Effectiveness

There is no construction associated with this alternative, so there are no short-term impacts on workers, the community, or the environment. However, the RAOs and therefore the SRGs cannot be achieved within a reasonable timeframe.

Implementability

Implementability evaluation for this alternative primarily includes technical and administrative feasibility.

Technical Feasibility. This alternative does not have a monitoring or construction component associated with it. Therefore, there are no issues concerning its technical implementation.

Administrative Feasibility. The administrative implementability of this alternative is low in terms of its ability to obtain approvals from other agencies.

Cost

Taking no action would require no expenditure.

5.3.2 Alternative 2—ICs

Alternative 2 consists of continued implementation of ICs in the form of land use restrictions, as described in Section 5.1.2.

Overall Protection of Human Health and the Environment

Alternative 2 is considered protective of human health because the land use restrictions would prevent or minimize future exposure to the contaminated soil. However, land use restrictions are not protective of the environment because ICs will not reduce the potential ecological exposures to mercury-contaminated sediment in the emergent wetland.

Compliance with ARARs

The alternative will not comply with the location- specific ARARs identified in Table B-2, Appendix B. Location-specific ARARs apply to the preservation of wetlands, and under this alternative, the wetland contamination will be left unaddressed. There are no action-specific ARARs that apply to Alternative 2.

Long-Term Effectiveness and Permanence

The ICs in place are expected to be adequate and reliable, based on their continued implementation. Use restrictions, which prevent construction and other activities on the contaminated soil, must be enforced. However, the ICs would not be effective at mitigating contamination in the AAs because the residual risks to the human health and ecological receptors remain the same.

Reduction of Toxicity, Mobility, and Volume through Treatment

Treatment is not considered under this alternative.

Short-Term Effectiveness

There are no construction activities associated with this alternative, so the short-term impacts on workers, the community, or the environment are minimal. However, similar to Alternative 1, the RAOs and therefore the SRGs cannot be achieved within a reasonable timeframe.

Implementability

Implementability evaluation for this alternative primarily includes technical and administrative feasibility.

Technical Feasibility. There are no technical difficulties associated with the implementation of this alternative.

Administrative Feasibility. Surface soil and wetland sediment would likely remain contaminated for years under this alternative. Therefore, long-term administrative resources must be expended to conduct the 5-year site reviews required by the NCP. In addition, administrative resources would be required on an ongoing basis to administer the ICs. The long-term implementation of ICs would require coordination with NSF-IH staff and the federal, state, and local government agencies.

Cost

The lifetime O&M present worth cost of approximately $96,000 consists primarily of site inspections and 5-year reviews. Because there are no capital costs associated with this alternative (startup costs are included in the lifetime O&M costs), the total present worth is equal to the lifetime O&M present-worth cost. The cost estimate details are provided in Appendix D.

5.3.3 Alternative 3— Excavation of Upland Area Surface Soil and Wetland Area Sediment, Offsite Disposal, Site Restoration, and ICs

Alternative 3 involves excavation and offsite disposal of the surface soil and emergent wetland sediment AAs, restoring the AAs, and implementing ICs. The components of Alternative 3 are described in Section 5.1.3.

Overall Protection of Human Health and the Environment

Alternative 3 is considered protective of human health and the environment. This alternative would remove the contaminated surface soil and emergent wetland sediment, thereby removing all FFS COCs. Human health also would be protected through a continuous implementation of ICs for the subsurface soil AA. The RAOs and therefore the SRGs would be achieved.

Compliance with ARARs

This alternative will comply with the location-, and action-specific ARARs identified in Tables B-2 and B-3 of Appendix B, respectively—specifically the location-specific protection of wetlands, which would be met through recreating and improving the wetlands; the action-specific RCRA disposal restrictions, which would be met through offsite disposal at a regulated facility; and the action-specific erosion and sediment controls, would be met by implementing best management practices and state guidance for conducting site/earth works.

Long-Term Effectiveness and Permanence

Releases of mercury into the sewer drain have long since ceased at the Lab Area. Improvements to sewer pipes have been made. Lastly, lead abatement has been conducted to mitigate the buildings containing lead-based paints. These actions, combined with the excavation, offsite disposal, and restoration of the soil and wetland area sediment, as well as improvement of the surface water management practices, would minimize the residual risks associated with mercury and lead to acceptable levels at the site. Enforcement of the ICs for the subsurface soil would eliminate the residual mercury risks in this medium. Restoration of the emergent wetland would improve the habitat quality of the wetland in the long run. Based on these facts, Alternative 3 fully satisfies the long-term effectiveness and permanence criterion.

Reduction of Toxicity, Mobility, and Volume through Treatment

This alternative does not include treatment of contaminated soil, but it would reduce the toxicity, mobility, and volume of contaminants through removal and containment of the contaminated media at a permitted facility offsite.

Short-Term Effectiveness

Under this alternative, RAOs, in terms of soil removal and disposal, will be met within 3 to 6 months. During this period, the NSF-IH daily operations may be affected because of the excavation activities and transportation of the excavated material offsite. Short-term impacts to the remediation workers resulting from the implementation of this alternative will be minimized as much as possible through good health and safety practices and properly trained personnel. Also, erosion control measures will be used to prevent any discharge of waste from the Lab Area during excavation.

Implementability

Implementability evaluation for this alternative primarily includes technical and administrative feasibility.

Technical Feasibility. Excavation and landfill disposal are technically and administratively feasible because the technologies have become standard practices.

Administrative Feasibility. Alternative 3 is administratively feasible because it has gained a preference from IHIRT.

Cost

Alternative 3 has an approximate estimated capital cost of $378,200. This cost is associated primarily with the removal (excavation), transportation and offsite disposal of soil and sediment, and site and wetland restoration. O&M activities under this alternative are associated with field inspections and replanting the wetlands. The present-worth lifetime O&M cost is approximately $19,400, and the total present-worth value of this alternative is estimated at $397,600. The cost estimate details are provided in Appendix D.

5.4 Comparative Analysis of RAs

In the following discussion, the RAs are evaluated in relation to one another based on each of the seven criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. Table 5-1 presents the results of comparative analysis of the RAs.

5.4.1 Overall Protection of Human Health and the Environment

Alternatives 1 and 2 are not protective of human health and the environment. Alternative 3 provides the greatest extent of protection for human health and the environment because the surface soil and sediment containing mercury above human health and ecological SRGs, respectively, would be removed.

5.4.2 Compliance with ARARs

Compliance with ARARs is not applicable to Alternative 1. Alternative 2 satisfies the location- and action-specific ARARs criteria; however, it is not compliant with the chemical-specific ARARs because it fails to achieve the SRGs. Alternative 3 complies with all applicable ARARs.

5.4.3 Long-Term Effectiveness and Permanence

Under Alternatives 1 and 2, the magnitude of residual risks would remain the same as the current conditions because no planned activities would be performed. Alternative 3 would achieve the SRGs in a short time frame by removal action.

The adequacy and reliability of controls under Alternative 1 is non-existent. The enforcement of the controls presented in Alternative 2 will determine their reliability. Alternative 3 is the most reliable approach because the contamination in surface soil and sediment would be removed to below SRG concentrations.

5.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

None of the alternatives would reduce the toxicity, mobility, or volume of contamination through treatment.

5.4.5 Short-Term Effectiveness

Alternative 3 presents the most impact on the daily operation of NSF-IH and the surrounding community because of the required excavation, backfilling, and transportation activities. However, it is the most effective alternative in the shortest amount of time to achieve the RAOs. Alternatives 1 and 2 would not be effective in mitigating the contamination at the Lab Area below SRG levels, and are thus incapable of meeting the RAOs.

5.4.6 Implementability

Technical Implementability. All the alternatives are technically implementable because none involves any emerging or innovative technology.

Administrative Implementability. Acceptance by the regulatory agencies of all the alternatives remains to be seen. However, Alternative 3 would likely receive the regulatory agencies' approval because of its capability to satisfy most of NCP criteria. Alternatives 1 and 2 have a poor administrative feasibility because a prolonged commitment in administrative resources (30 years or longer) would be required and, therefore, the approval of its implementation from other agencies would be unlikely.

5.4.7 Cost

Alternative 1 implies zero cost, although it should be noted that the cost for performing the 5-year reviews as required by CERCLA when the contamination is left in place would not be included in the cost. Alternative 2 is the least expensive approach, but would not meet the RAOs. Alternative 3 is the most expensive remedy, based on the capital cost associated with removal and offsite disposal of the surface soil and wetland sediment. However, it is the only remedy that will meet the SRGs and RAOs. Table 5-2 presents a cost summary of the three alternatives.

All costs are within the range of -30 percent to +50 percent accuracy associated with conceptual level cost estimates for an FFS, as outlined by the EPA guidance (EPA, 2000).

Table 5-1
Comparative Analysis of Remedial Alternatives
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Evaluation Criteria	**Alternative 1** **No Action**	**Alternative 2** **ICs**		**Alternative 3** **Excavation, Off-Site Dipsposal, and Wetland Restoration**	
Overall Protection of Human Health and the Environment	Not protective of human health and the environment	Protective of human health, as land use restrictions would prevent or minimize future exposure to the contaminated soil. Not protective of the environment.		Alternative 3 is considered protective of human health and the environment. This alternative would remove the contaminatesd surface soil and sediment, thereby removing all FFS COCs. The RAOs, and therefore the SRGs, would be achieved	
Compliance With ARARs	Not applicable	In compliance with location-specific ARARs. No chemical- or action-specific ARARs that apply to Alternative 2.		In compliance with location- and action-specific ARARs. No chemical-specific ARARs that apply to Alternative 3.	
Long-Term Effectiveness and Permanence	There would be no reduction in risk to human or ecological receptors under this alternative.	The ICs in place are expected to be adequate and reliable, which is based on their continued implementation. Use restrictions, which prevent construction and other activities on the contaminated soil, must be enforced. However, the ICs would not be effective at mitigating contamination in the upland or wetland areas.		Dumping activities, the source of the mercury contamination, have long since ceased at the Lab Area. Excavation of sites contaminated with mercury above human health (upland) or ecological (wetland) SRGs would remove any risk of human or ecological exposure.	
Reduction of Toxicity, Mobility, or Volume Through Treatment	This alternative does not include treatment.	This alternative does not include treatment.		This alternative does not include treatment of contaminated soil, but will reduce the toxicity, mobility, and volume of contaminants through removal.	
Short-Term Effectiveness	No impact to community, workers, and the environment from remedial activities because this alternative involves doing nothing. RAOs and SRGs cannot be achieved within a reasonable time frame.	There are no construction activities associated with this alternative, and thus the short-term impacts on workers, the community, or the environment are minimal. However, similar to Alternative 1, the RAOs and thus the SRGs cannot be achieved within a reasonable timeframe.		Daily operations for 3 to 6 months may be impacted because of excavation activities and transportation of the excavation material off-site. Short-term impacts to remediation workers will be minimized through implementation of good health and safety practices.	
Implementability	Has no ability to monitor the effectiveness of this remedy and ability to obtain approvals from other agencies is unlikely	Easily implemented but requires long-term administrative commitment		Excavation and landfill disposal are technically and administratively feasible because the technologies have become standard practices.	
Cost	$0	**Capital:**	**$0**	**Capital:**	**$378,155**
		Lifetime Present Worth O&M:	$95,962	Lifetime Present Worth O&M:	$19,361
		Total Present Worth:	$95,962	Total Present Worth:	$397,516
		Cost is based on 30-year time frame assumption.		Cost is based on 5-year time frame assumption.	

Table 5-2
Preliminary Remediation Cost Summary
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Remedial Alternative	Description	Construction Time (weeks)	Operation Time (years)	Capital Cost	2009 Lifetime O&M Cost	Lifetime PW O&M	Total PW
1	No Action	NA	NA	$0	$0	$0	$0
2	ICs	NA	30	$0	$171,558	$95,692	$95,692
3	Excavation, Off-Site Disposal, and Wetland Restoration	3.0	5	$378,155	$22,050	$18,497	$397,516

Notes:
The source zone removal actions were completed under previous site investigations

SECTION 6

References

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Appendix A
Wetland Delineation Technical Memorandum

Wetland Delineation for Lab Area, Naval District Washington, Indian Head; Indian Head, Maryland

PREPARED FOR: Gunarti Coghlan/CH2M HILL

PREPARED BY: Hylton Hobday/CH2M HILL

Steve Graff/CH2M HILL

COPIES: Bernard Holcomb/CH2M HILL

DATE: April 17, 2006

1. Introduction

CH2M HILL was tasked with identifying and delineating a potential wetland at the Lab Area project site (Site), located east of Patterson Road and surrounded by buildings 0444, 0303, 0101, 0102, 0103, 0502, 0109, and 109A, at the Naval District Washington, Indian Head (NDWIH) in Indian Head, Maryland. This report summarizes the results of wetland delineation activities conducted by CH2M HILL personnel at this location (Figure 1).

On April 12, 2006, field studies aimed at locating and delineating potential wetland areas at the Site were initiated and completed. These studies were conducted to assist NDWIH in avoiding and/or minimizing, to the greatest extent practicable and feasible, potential impacts to wetland areas, resulting from any future remediation activities conducted within the Site or vicinity.

2. Methodologies

The wetland delineation event was conducted in accordance with the routine onsite methodology described in the 1987 U.S. Army Corps of Engineers (ACOE) Manual. ACOE routine delineation data sheets were completed in the field, and characterized the resources observed. Each data sheet included the vegetation species and stratum (herbaceous, shrub, or tree layer), the presence or absence of wetland hydrology, and the soil profiles observed.

Areas meeting the technical criteria of the ACOE Manual were flagged and surveyed. The location of the wetland/upland boundary was marked with pink flags. The flagged locations were logged by CH2M HILL utilizing a Global Positioning System (GPS) Pathfinder® Pro XR backpack unit during the event. The surveyed boundary is depicted on the wetland delineation map included with this report (Figure 1).

Prior to conducting field investigations, existing resource information for the Site was reviewed. These resources included the material referenced below.

- Indian Head Quadrangle, United States Geological Survey (USGS) Topographic Map (Figure 1);
- Indian Head Quadrangle, National Wetlands Inventory (NWI) Map;

- Natural Resources Conservation Service (NRCS), Charles County Soils Map; and
- NRCS Charles County Hydric Soils List.

The references were reviewed to develop a preliminary understanding of potential wetlands existing on-site. These results were then verified in the field during the delineation activities.

3. Wetland Delineation Results

This section presents the results of the wetland delineation activities performed at the Site. One potential resource area was identified. This potential wetland is located in the Lab Area of the NDWIH facility.

3.1 Lab Area Wetland

The Lab Area wetland is classified under the NWI wetland classification system as Palustrine Emergent (PEM). The total area encompassed is 12,807.8 square feet. Small ponded areas lined with fine silts and leaf debris were present. This area serves as a drainage basin for stormwater runoff from the upper grassy fields, surrounding buildings, maintained lawns and the paved access roads. This PEM wetland is encircled by buildings 0444, 0303, 0101, 0102, 0103, 0502, 0109, and 109A. Flags labeled WL-01 through WL-27 were placed around the wetland boundary.

The PEM area was observed to be predominantly marsh. Vegetation within this section is comprised of mixed upland and wetland species such as Sweetgum (*Liquidambar styraciflua*), Greenbrier (*Smilax rotundifolia*), Poison Ivy (*Toxicodendron radicans*), Sedges (*Carex sp*.), Rush (*Juncus sp*.), and Cattails (*Typha latifolia*). Stands of medium to high canopy trees are also present within the wetland boundary zone. These are comprised of Sweetgum, Sugar maple (*Acer saccharum*), Southern Red Oak (*Quercus falcata*), White Oak (*Quercus alba*), Northern Red Oak (*Quercus rubra*), and Hickory (*Carya sp*.). The upper edges also included scattered stands of Japanese honeysuckle (*Lonicera japonica*) and seedling American holly (*Ilex opaca*) and Cedar (*Cedrus sp.)*.

Hydrologic indicators observed in the wetland portions of the Lab Area included soils saturated at the surface, standing water in the test pits, water-stained leaves, sediment deposits, and defined wetland drainage patterns. Four lowland soil pits and six upland soil pits were excavated along the suspected boundaries to define the wetland line. Data sheets for the ten soil pits (TP-L-01 through TP-L-04 and TP-U-01 through TP-U-06) are included with this report. No wildlife was observed in the area at the time of delineation.

The soil type in the majority of the Lab Area wetland is classified as Beltsville silt loam (B1B2). These soils are commonly observed in upland portions of the Coastal Plain, are typically very deep, moderately well drained, and with 0 to 40% slopes (USDA, Charles County, MD). Under ACOE regulations, this resource area was determined to be a wetland and therefore is subject to regulation.

Analysis of the Site and interviews with NDWIH personnel indicated that the area of this study had, in historical times, been unnaturally saturated due to old, fractured underground water piping. This had allowed the small, naturally-occurring drainage area to expand up the slope along the drainage from the broken pipe over time. Opportunistic hydrophytic plant species colonized the newly-moist soils over the drainage. These fractured underground pipes were repaired within the last few years which is changing the hydrology and associated vegetation. This is evident due to 1) mature upland tree species being located along the immediate wetland boundary, and 2) the young stands of cattail are dying along the upper slopes surrounding the wetland. The edges of this wetland are not able to exist without the additional sources of moisture previously supplied by the broken piping. The mapped wetlands show this change (Figure 1). To sustain these areas that used to be wetland we would need to restore the hydrology. This could be accomplished by regrading the soil topography to allow existing surface water runoff to collect naturally, as well as to provide access to the ground water hydrology. Poorly-drained substrate could also be incorporated to assist with moisture retention.

3.4 Project Summary and Conclusions

Portions of the previously defined wetland limits in the Lab Area display all three criteria (vegetation, hydrology, and hydric soils), which classify them as a jurisdictional wetland and meets the full criteria of a wetland according to the ACOE 1987 Manual. However, the outer fringes no-longer meet all three criteria, and thus cannot be defined as wetland. This small freshwater area is likely the result of old, leaking water pipes buried along and under the project Site, which have since been repaired. To sustain the full extent of the wetland, the soil topography would have to be re-graded to allow water to be collected and retained naturally, and to access the ground water hydrology. Poorly-drained substrate could also be incorporated to assist with moisture retention.

Pursuant to ACOE regulations, restoration and mitigation would be required for temporary and/or permanent impact to the regulated wetlands resulting from any remedial practices implemented on the project Site.

File Path: V:\18gis\IndianHead\figures\lab_area.apr

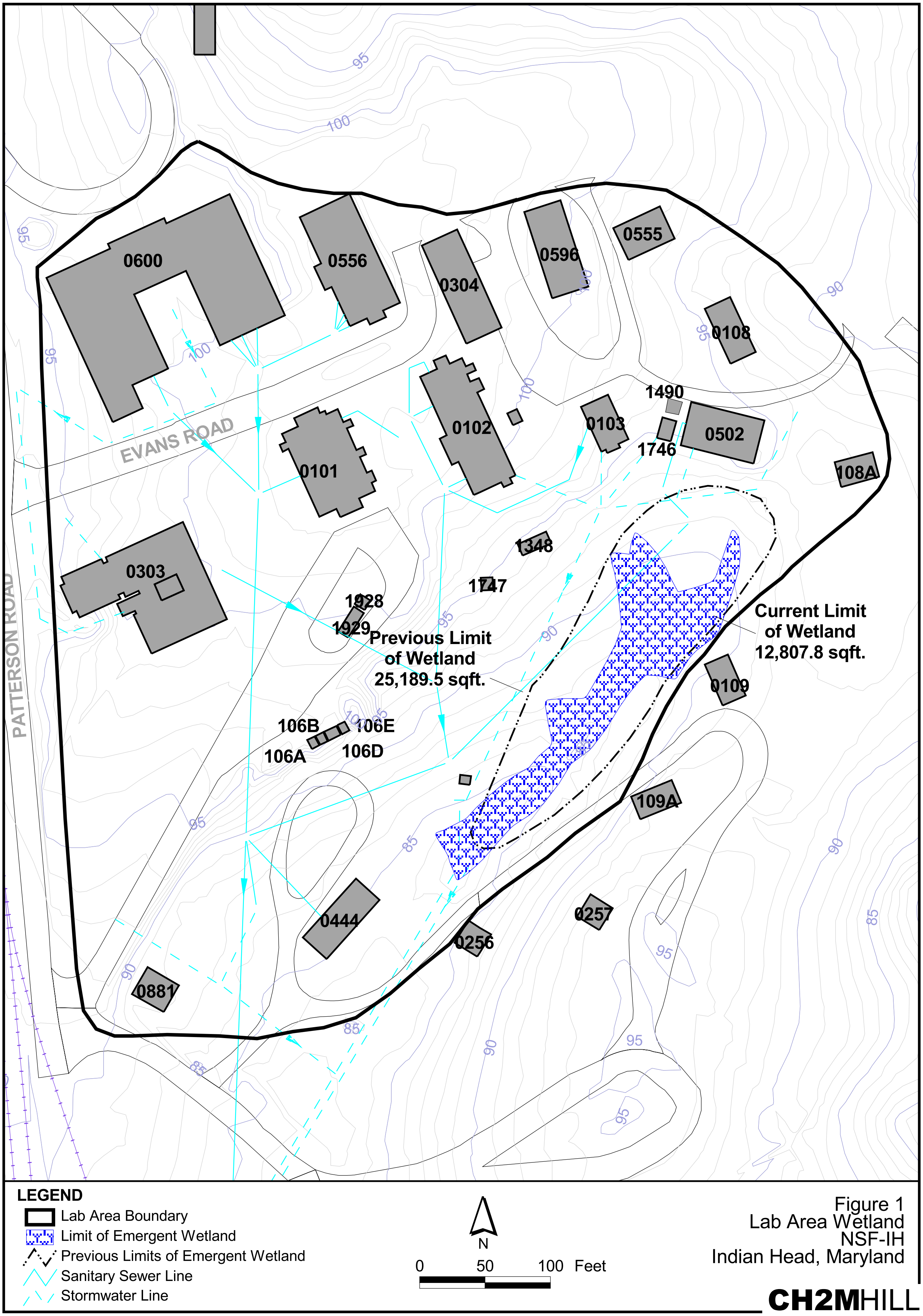

Figure 1
Lab Area Wetland
NSF-IH
Indian Head, Maryland

CH2MHILL

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	01
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-L-01

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Typha latifolia*	herbaceous	OBL	9.			
2.	*Liquidambar styraciflua*	shrub	FAC	10.			
3.				11.			
4.				12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Wetland vegetation was dominant.

HYDROLOGY

____ Recorded Data (Describe in Remarks):	
____ Stream, Lake or Tide Gauge	
____ Aerial Photographs	
____ Other	
X No Recorded Data Available	

Wetland Hydrology Indicators:

Primary Indicators:

- ____ Inundated
- X Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

- X Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- ____ Local Soil Survey Data
- X FAC-Neutral Test
- ____ Other (Explain in Remarks)

Field Observations:

Depth of Surface Water:	N/A	(in.)
Depth to Free Water in Pit:	4.5	(in.)
Depth to Saturated Soil	7.5	(in.)

Remarks: Wetland hydrology was present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-3	A	10YR 5/4	N/A	N/A	Silty loam
3-12	B	10YR 2/1	N/A	N/A	Silty loam / organic

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
X	Sulfidic Odor		Organic Streaking in Sandy Soils
X	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Wetland soil characteristics were observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	
Wetland Hydrology Present?	Yes	
Hydric Soils Present?	Yes	Is this Sampling Point Within a Wetland? Yes

Remarks: All three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	02
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-L-02

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Typha latifolia*	herbaceous	OBL	9.		
2. *Liquidambar styraciflua*	shrub	FAC	10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Wetland vegetation was dominant.

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: 8.0 (in.)

Depth to Saturated Soil 4.0 (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- X Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- X FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: Wetland hydrology was observed.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	10YR 5/4	N/A	N/A	Silty loam

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
X	Sulfidic Odor		Organic Streaking in Sandy Soils
X	Aquic Moisture Regime		Listed on Local Hydric Soils List
	Reducing Conditions		Listed on National Hydric Soils List
	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Wetland soil characteristics were observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	
Wetland Hydrology Present?	Yes	
Hydric Soils Present?	Yes	Is this Sampling Point Within a Wetland? Yes

Remarks: All three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland
Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	03
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-L-03

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Smilax rotundifolia*	shrub	FAC	9.		
2. *Liquidambar styraciflua*	shrub	FAC	10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Wetland vegetation was dominant.

HYDROLOGY

___ Recorded Data (Describe in Remarks):	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs	___ Inundated
___ Other	X Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations:	X Sediment Deposits
	X Drainage Patterns in Wetlands
Depth of Surface Water: N/A (in.)	Secondary Indicators (2 or more required):
	___ Oxidized Root Channels in Upper 12 Inches
Depth to Free Water in Pit: 0 (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil 0 (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks: Wetland hydrology was present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	10YR 5/2	N/A	N/A	Silty loam

Hydric Soil Indicators:

	Histosol		Concretions
	Histic Epipedon		High Organic Content in Surface Layer in Sandy Soils
X	Sulfidic Odor		Organic Streaking in Sandy Soils
X	Aquic Moisture Regime		Listed on Local Hydric Soils List
X	Reducing Conditions		Listed on National Hydric Soils List
	Gleyed or Low-Chroma Colors		Other (Explain in Remarks)

Remarks: Wetland soil characteristics were observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	
Wetland Hydrology Present?	Yes	
Hydric Soils Present?	Yes	Is this Sampling Point Within a Wetland? Yes

Remarks: All three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	04
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-L-04

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Juncus sp.*	herbaceous	FACW	9.			
2.	*Toxicodendron radicans*	shrub	FAC	10.			
3.				11.			
4.				12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Wetland vegetation was dominant.

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water:	N/A	(in.)
Depth to Free Water in Pit:	11.0	(in.)
Depth to Saturated Soil	1.0	(in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- X Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- X Sediment Deposits
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- ____ Local Soil Survey Data
- X FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: Wetland hydrology was present.

SOILS

Map Unit Name (Series and Phase): Beltsville Silt Loam (B1B2)

Drainage Class: Moderately well drained

Taxonomy (Subgroup):

Field Observations Confirm Mapped Type? Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	A	10YR 4/2	N/A	N/A	Silty loam
5-12	B	10YR 5/4	N/A	N/A	Silty loam

Hydric Soil Indicators:

____	Histosol	____	Concretions
____	Histic Epipedon	____	High Organic Content in Surface Layer in Sandy Soils
X	Sulfidic Odor	____	Organic Streaking in Sandy Soils
____	Aquic Moisture Regime	____	Listed on Local Hydric Soils List
____	Reducing Conditions	____	Listed on National Hydric Soils List
____	Gleyed or Low-Chroma Colors	____	Other (Explain in Remarks)

Remarks: Wetland soil characteristics were observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes

Wetland Hydrology Present? Yes

Hydric Soils Present? Yes

Is this Sampling Point Within a Wetland? Yes

Remarks: All three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	01
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-01

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Cerastium vulgatum*	herbaceous	FACU-	9.		
2. *Fragaria virginina*	herbaceous	FACU	10.		
3. *Taraxacum officinale*	herbaceous	FACU-	11.		
4. *Viola papilionacea*	herbaceous	FAC	12.		
5. *Houstonia caerulea*	herbaceous	FACU	13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 20%

Remarks: Wetland vegetation was not dominant.

HYDROLOGY

___ Recorded Data (Describe in Remarks):	Wetland Hydrology Indicators:
___ Stream, Lake or Tide Gauge	Primary Indicators:
___ Aerial Photographs	___ Inundated
___ Other	___ Saturated in Upper 12 Inches
X No Recorded Data Available	___ Water Marks
	___ Drift Lines
Field Observations:	___ Sediment Deposits
	___ Drainage Patterns in Wetlands
Depth of Surface Water: N/A (in.)	Secondary Indicators (2 or more required):
	X Oxidized Root Channels in Upper 12 Inches
Depth to Free Water in Pit: N/A (in.)	___ Water-Stained Leaves
	___ Local Soil Survey Data
Depth to Saturated Soil N/A (in.)	___ FAC-Neutral Test
	___ Other (Explain in Remarks)

Remarks: Wetland hydrology was not present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	A	10YR 2/1	N/A	N/A	Sandy loam
5-12	B	2.5YR 6/3	N/A	N/A	Silty loam

Hydric Soil Indicators:

________ Histosol	________ Concretions
________ Histic Epipedon	________ High Organic Content in Surface Layer in Sandy Soils
________ Sulfidic Odor	________ Organic Streaking in Sandy Soils
________ Aquic Moisture Regime	________ Listed on Local Hydric Soils List
________ Reducing Conditions	________ Listed on National Hydric Soils List
________ Gleyed or Low-Chroma Colors	________ Other (Explain in Remarks)

Remarks: Wetland soil characteristics were not observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	No	
Wetland Hydrology Present?	No	
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland? No

Remarks: All three criteria were not met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	02
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-02

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. *Liquidambar styraciflua*	shrub	FAC	9.		
2.			10.		
3.			11.		
4.			12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Potential wetland vegetation is present.

HYDROLOGY

___ Recorded Data (Describe in Remarks): ___ Stream, Lake or Tide Gauge ___ Aerial Photographs ___ Other X No Recorded Data Available	Wetland Hydrology Indicators: Primary Indicators: ___ Inundated ___ Saturated in Upper 12 Inches ___ Water Marks ___ Drift Lines ___ Sediment Deposits ___ Drainage Patterns in Wetlands
Field Observations: Depth of Surface Water: N/A (in.) Depth to Free Water in Pit: N/A (in.) Depth to Saturated Soil N/A (in.)	Secondary Indicators (2 or more required): X Oxidized Root Channels in Upper 12 Inches ___ Water-Stained Leaves ___ Local Soil Survey Data ___ FAC-Neutral Test ___ Other (Explain in Remarks)

Remarks: Wetland hydrology was not present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	10YR 5/6	N/A	N/A	Clay loam

Hydric Soil Indicators:

________ Histosol	________ Concretions
________ Histic Epipedon	________ High Organic Content in Surface Layer in Sandy Soils
________ Sulfidic Odor	________ Organic Streaking in Sandy Soils
________ Aquic Moisture Regime	________ Listed on Local Hydric Soils List
________ Reducing Conditions	________ Listed on National Hydric Soils List
________ Gleyed or Low-Chroma Colors	________ Other (Explain in Remarks)

Remarks: High iron content present in soil. Wetland soil characteristics were not observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	
Wetland Hydrology Present?	No	
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland? No

Remarks: All three criteria were not met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	03
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-03

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Liquidambar styraciflua*	shrub	FAC	9.			
2.				10.			
3.				11.			
4.				12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 100%

Remarks: Potential wetland vegetation is present.

HYDROLOGY

____ Recorded Data (Describe in Remarks):
- ____ Stream, Lake or Tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: Wetland hydrology was not present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	7.5YR 4/6	N/A	N/A	Clay loam

Hydric Soil Indicators:

- ________ Histosol
- ________ Histic Epipedon
- ________ Sulfidic Odor
- ________ Aquic Moisture Regime
- ________ Reducing Conditions
- ________ Gleyed or Low-Chroma Colors
- ________ Concretions
- ________ High Organic Content in Surface Layer in Sandy Soils
- ________ Organic Streaking in Sandy Soils
- ________ Listed on Local Hydric Soils List
- ________ Listed on National Hydric Soils List
- ________ Other (Explain in Remarks)

Remarks: High iron content present in soil. Wetland soil characteristics were not observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	
Wetland Hydrology Present?	No	
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland? No

Remarks: All three criteria were not met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	04
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-04

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Liquidambar styraciflua*	shrub	FAC	9.			
2.	*Fragaria virginina*	herbaceous	FACU	10.			
3.	*Lonicera japonica*	herbaceous	FAC-	11.			
4.				12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 33%

Remarks: Wetland vegetation was not dominant.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (in.)

Depth to Free Water in Pit: N/A (in.)

Depth to Saturated Soil N/A (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Wetland hydrology was not observed.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	7.5YR 4/6	N/A	N/A	Clay loam

Hydric Soil Indicators:

________ Histosol	________ Concretions
________ Histic Epipedon	________ High Organic Content in Surface Layer in Sandy Soils
________ Sulfidic Odor	________ Organic Streaking in Sandy Soils
________ Aquic Moisture Regime	________ Listed on Local Hydric Soils List
________ Reducing Conditions	________ Listed on National Hydric Soils List
________ Gleyed or Low-Chroma Colors	________ Other (Explain in Remarks)

Remarks: High iron content observed in soil. Hydric soil characteristics were not present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	No		
Wetland Hydrology Present?	No		
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland?	No

Remarks: None of the three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland

Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	05
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-05

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Liquidambar styraciflua*	shrub	FAC	9.			
2.	*Quercus rubra*	tree	FACU-	10.			
3.	*Potentilla simplex*	herbaceous	FACU	11.			
4.	*Lonicera japonica*	herbaceous	FAC-	12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 25%

Remarks:

HYDROLOGY

___ Recorded Data (Describe in Remarks): ___ Stream, Lake or Tide Gauge ___ Aerial Photographs ___ Other X No Recorded Data Available	Wetland Hydrology Indicators: Primary Indicators: ___ Inundated ___ Saturated in Upper 12 Inches ___ Water Marks ___ Drift Lines ___ Sediment Deposits ___ Drainage Patterns in Wetlands
Field Observations: Depth of Surface Water: N/A (in.) Depth to Free Water in Pit: N/A (in.) Depth to Saturated Soil N/A (in.)	Secondary Indicators (2 or more required): ___ Oxidized Root Channels in Upper 12 Inches ___ Water-Stained Leaves ___ Local Soil Survey Data ___ FAC-Neutral Test ___ Other (Explain in Remarks)

Remarks: Wetland hydrology was not observed.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-12	A	10YR 5/4	N/A	N/A	Silty loam

Hydric Soil Indicators:

________ Histosol	________ Concretions
________ Histic Epipedon	________ High Organic Content in Surface Layer in Sandy Soils
________ Sulfidic Odor	________ Organic Streaking in Sandy Soils
________ Aquic Moisture Regime	________ Listed on Local Hydric Soils List
________ Reducing Conditions	________ Listed on National Hydric Soils List
________ Gleyed or Low-Chroma Colors	________ Other (Explain in Remarks)

Remarks: Hydric soil characteristics were not observed.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	No	
Wetland Hydrology Present?	No	
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland? No

Remarks: None of the three criteria were met.

DATA FORM
ROUTINE WETLAND DETERMINATION

Project/Site:	Indian Head – Lab Area	Date:	4/12/2006
Applicant/Owner:	Naval District Washington, Indian Head (NDWIH)	County:	Charles City
Investigator:	Hylton Hobday / Steve Graff	State:	Maryland
Do Normal Circumstances exist on the site?	YES	Community ID:	IH
Is the site significantly disturbed (Atypical Situation)?	NO	Transect ID:	06
Is the area a potential Problem Area? (If needed, explain on reverse)	NO	Plot ID:	TP-U-06

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Liquidambar styraciflua*	shrub	FAC	9.			
2.	*Quercus falcata*	tree	FACU-	10.			
3.				11.			
4.				12.			
5.				13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-). 50%

Remarks: Potential wetland vegetation is present, but not dominant.

HYDROLOGY

___ Recorded Data (Describe in Remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water:	N/A	(in.)
Depth to Free Water in Pit:	N/A	(in.)
Depth to Saturated Soil	N/A	(in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Wetland hydrology is not present.

SOILS

Map Unit Name (Series and Phase):	Beltsville Silt Loam (B1B2)	Drainage Class:	Moderately well drained
Taxonomy (Subgroup):		Field Observations Confirm Mapped Type?	Yes

Profile Description

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/ Size/Contrast	Texture, Concretions, Structure, etc.
0-5	A	10YR 4/2	N/A	N/A	Silty loam
5-12	B	10YR 5/4	N/A	N/A	Silty loam

Hydric Soil Indicators:

________ Histosol	________ Concretions
________ Histic Epipedon	________ High Organic Content in Surface Layer in Sandy Soils
________ Sulfidic Odor	________ Organic Streaking in Sandy Soils
________ Aquic Moisture Regime	________ Listed on Local Hydric Soils List
________ Reducing Conditions	________ Listed on National Hydric Soils List
________ Gleyed or Low-Chroma Colors	________ Other (Explain in Remarks)

Remarks: Hydric soil conditions were not present.

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	No	
Wetland Hydrology Present?	No	
Hydric Soils Present?	No	Is this Sampling Point Within a Wetland? No

Remarks: All three criteria were not met.

Photo 1: View of Lab Area wetland, looking northeast. The clump of cattails (*Typha latifolia*) in the center is the southwestern extent of the wetland. Building 0256 is on the immediate right.

Photo 2: View of the southeastern edge of the Lab Area wetland. Cattails can be seen growing in the center. Oak (*Quercus sp.*) and hickory (*Carya sp.*) surround the low-lying areas.

Photo 3: View of the Lab Area wetland looking south. Mowed lawns surround this wetland area.

Photo 4: North/northeast view of wetland. Clusters of young Sweetgum shrubs (*Liquidambar styraciflua*) can bee seen to the left. Cattails can be seen in the moister, central areas.

Photo 5: View of Lab Area wetland looking northwest towards buildings 0101 and 0102. Small clumps of rush (*Juncus sp.*) can be seen in the foreground.

Photo 6: View into the Lab Area wetland looking west across clumps of rush.

Photo 7: Small ponded area in the center of the Lab Area wetland. Upland species of trees can be found in relatively close proximity (*Quercus sp.* and *Carya sp.*).

Photo 8: View of small ponded area in center of wetland. Buildings 0256 and 0257 can be seen in the background.

Photo 9: View of Test Pit (TP) Number TP-U-01 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Photo 10: View of TP-L-01 in the lowland area of the site. Freestanding water was observed in the test pit.

Photo 11: View of TP-U-02 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Photo 12: View of TP-L-02 in the lowland area of the site. Freestanding water was observed in the test pit.

Photo 13: View of TP-U-03 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Photo 14: View of TP-L-03 in the lowland area of the site. Freestanding water was observed in the test pit.

Photo 15: View of TP-U-04 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Photo 16: View of TP-L-04 in the lowland area of the site. Freestanding water was observed in the test pit.

Photo 17: View of TP-U-05 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Photo 18: View of TP-U-06 on the upland boundary of the project site. No freestanding water was observed in the test pit.

Appendix B
Applicable or Relevant and Appropriate Requirements Tables

Table B-1
Chemical-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Chemicals & Relevant Media	Requirement	Prerequisites	Citation	ARAR or TBC	Comments
Surface water	Water Management Program approval for short-term discharges and NPDES for long-term discharges.	None.	CWA: 40 CFR 122-123 NPDES permit program	TBC	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges. Limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the State's surface waters	COMAR 26.08, chapters 1 through 7	TBC	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Soil as a source of groundwater contamination	Regulated substances are not to exceed the soil-to-groundwater pathway numeric value throughout the soil column.	Potential exposure to groundwater	CERCLA, EPA Region III RBC tables, and EPA soil screening guidance (EPA/540/R-94/101)	TBC	This regulation is applicable where contaminants in soil are also present in groundwater at concentrations above PRGs.
Surface water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	TBC	This regulation is applicable for remedial actions that may affect surface water quality.

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
EPA - U.S. Environmental Protection Agency
NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered

Table B-2
Location-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Historic Sites, Buildings, and Antiquities Act					
Historic sites	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467; 40 CFR 6.301 (a)	Relevant and Appropriate	The regulations are relevant and appropriate in situations where remedial actions may adversely affect the historical structures located on the site.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, Fish and Wildlife Conservation Act of 1980					
Area affecting streams or other water body	Provides protection for actions that would affect streams, wetlands, other water bodies or protected habitats. Any action taken should protect fish or wildlife.	Diversion, channeling or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 661; 16 USC 662; 16 USC 742a; 16 USC 2901; 50 CFR 83	Relevant and Appropriate	Response actions will incorporate protection for any area water body, wetlands, or protected habitats.
Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environment					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands. Wetlands of primary ecological significance must not be altered such that ecological systems in the wetlands are unreasonably disturbed.	Wetlands as defined by Executive Order 11990 Section 7.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	This regulation may be an ARAR for activities occurring in areas that meet the definition of a wetland. Remedial activities must minimize the destruction, loss, or degradation of the wetlands.
Clean Water Act, Section 404					
Wetland	The degradation Section requires degradation or destruction of wetlands and other aquatic sites to be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity: contributes to the violation of Maryland water quality standards; CWA Sec. 307; jeopardizes endangered or threatened species; or violates requirements of the Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Wetlands as defined by Executive Order 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2, 231.7, 231.8)	Applicable	Wetlands are present at the Lab Area. Remedial activities will comply with the requirements of this section of the Clean Water Act.
Surface Water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	TBC	Response actions will incorporate protection for aquatic life and human consumers of aquatic life.
Hazardous Waste Control Act (HWCA)					
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (b)	TBC	Portions of the site are within the 100-year flood zones. However, actions are not expected to involve hazardous waste. This would be TBC for nonhazardous waste.
Executive Order 11988, Protection of Floodplains					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	Portions of the site are within the 100-year flood zones, therefore the requirements of this regulation are applicable for any response actions that might involve the use of these areas.
Maryland State Location-Specific ARARs					
Threatened and Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on. May not reduce the likelihood of either the survival or recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or its habitat.	COMAR 08.03.08	Relevant and Appropriate	Requires action to conserve endangered fish species and the critical habitats they depend on.
Threatened and Endangered Fish Species					
Critical habitat upon which endangered or threatened fish species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on.	Determination of effect upon endangered or threatened fish species or its habitat.	COMAR 08.02.12	Relevant and Appropriate	These regulations are applicable if remedial actions may jeopardize endangered or threatened fish species. Currently, there are no federal or state endangered fish species at NSF-IH.
Fish and Fisheries					
Fisheries, locations where species of fish exist	Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon fish species or its habitat.	Annotated Code of Maryland Title 4	Applicable	Fish species inhabit in Mattawoman Creek. If response actions affect these species, the requirements of this title are applicable.

Table B-2
Location-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Wildlife					
Areas inhabited by wildlife	Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon wildlife species or its habitat.	Annotated Code of Maryland Title 10	Relevant and Appropriate	Wildlife species are present at NSF-IH. If response actions may affect wildlife species, the requirements of this title are applicable.
Nontidal Wetlands Protection Act, Maryland Nontidal Wetlands Regulations					
Wetland	Provides regulations for activities on or near nontidal wetlands (an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions). Must obtain a permit from the State in order to conduct certain regulated activities in a nontidal wetland, or within a buffer or an expanded buffer.	Activities that will occur on or near nontidal wetlands.	COMAR 26.23; Annotated Code of Maryland, Title 5; Code of MD, Title 8-1201;	Applicable	Nontidal wetlands are present at Site 11. A permit or letter of exemption from the Department of Natural Resources is required if remedial activities involve activities on or in nontidal wetlands.
Wetlands and Riparian Rights					
Wetlands	Requirements to preserve wetlands and prevent their destruction; requires a license for dredging or filling of wetlands.	Activities that can affect the integrity of wetlands, such as dredging or filling.	Annotated Code of Maryland Title 16	Applicable	Wetlands (tidal and nontidal) are present at Site 11. The requirements of this title are applicable for any response actions that may affect the integrity of these wetlands.
Construction on Nontidal Waters and Floodplains					
Nontidal waters and floodplains	Protect and maintain nontidal waterways and/or state of Maryland floodplains must follow these regulations	Activities that affect nontidal waterways and floodplains	COMAR 08.05.03	Relevant and Appropriate	Any remedial actions involving alteration to the streams bounding the site or floodplains (including temporary construction) are subject to these requirements.
Maryland Tidal Wetland Act					
Tidal Wetlands	Requirements for filling, construction, and dredging of open water and vegetated wetlans and marsh establishment.	Activities that affect tidal wetlands	COMAR 26.24	applicable	Wetlands (tidal and nontidal) are present at Site 11. The requirements of this title are applicable for any response actions that may affect the integrity of these wetlands.
Water Pollution Control Law					
Waters of the State	Establishes effective programs and provides additional and cumulative remedies to prevent, abate, and control pollution of the waters in the state.	Activities that will pollute the waters in the state.	COMAR 9, Parts 301-351	Relevant and Appropriate	This regulation is applicable for remedial actions that may affect water quality in local streams.
Maryland Water Pollution Control Regulations					
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges limitations and policy for antidegradation of the State's limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the surface waters of the state.	COMAR 26.08, Chapters 01-07	Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Water Management					
Water resources of the State	Provides for the conservation and protection of the water resources of the State by requiring that any land-clearing, grading, or other earth disturbances require an erosion- and sediment-control plan. Also provides that stormwater must be managed to prevent offsite sedimentation and maintain current site conditions.	Activities that affect the water resources of the State.	COMAR 26.17.01 COMAR 26.17.02, Annotated Code of Maryland Title 4	Applicable	The design for the remedial actions will incorporate the requirements of this regulation.

ARARs - Applicable or relevant and appropriate requirements.
RCRA - Resource Conservation and Recovery Act.
CFR - Code of Federal Regulations.
CWA- Clean Water Act.
DON - Department of Navy.

EO - Executive Order
FR - Federal Register.
HWCA - Hazardous Waste Control Act.
USC - United States Code.
TBC - To Be Considered.

Table B-3
Action-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal Action-Specific ARARs					
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 262.11	Applicable	Applicable for any operation where waste is generated. Remedial alternatives for the site may generate contaminated wastes.
Hazardous waste accumulation	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate hazardous waste.	40 CFR 262.34	Applicable	If waste generated at NSF-IH is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Recordkeeping	Generator must keep records of types and quantities of wastes generated.	Generate hazardous waste.	40 CFR 262.40	Relevant and appropriate	Administrative requirements are not ARARs for onsite CERCLA actions.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268.40	Applicable	Applicable to disposal of soil to a new location and placement in or on land containing land-disposal-restricted RCRA hazardous waste. The wastes generated from response actions at the Lab Area may be RCRA hazardous wastes.
Safe Drinking Water Act					
Actions that affect drinking water supply	Promulgates National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs)	Actions that affect drinking water supply	40 CFR 141	Relevant and appropriate	These regulations are ARARs for remedial actions at the site that affect the groundwater.
U.S. Department of Transportation, 49 USC 1802, et seq.*					
Hazardous Materials Transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq. or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the Federal Government.	49 CFR 171.2(f)	Applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Applicable	
Hazardous Materials Marking, Labeling, and Placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.300	Applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Applicable	
	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.302	Applicable	

Table B-3
Action-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Materials Marking, Labeling, and Placarding (cont.)	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.	None	49 CFR 172.303	Applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	The marking must be durable, in English, in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Applicable	
	Labeling of hazardous material packages shall be as specified in the list.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.400	Applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Applicable	
	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.		49 CFR 172.504	Applicable	
Occupational Safety and Health Administration (OSHA)					
Hazardous waste work	Requirements for hazardous waste workers such as training, personal protective equipment (PPE), and clothing must be met.	Hazardous waste work.	29 CFR 1904, 29 CFR 1910, 29 CFR 1926	Applicable	Remedial action activities at NSF-IH will involve hazardous waste workers; therefore the requirements of OSHA must be met.
Maryland State Action-Specific ARARs					
Maryland Hazardous Waste Regulations					
Storage, treatment or disposal, and transportation of hazardous waste	Regulations and procedures for the identifications, listing, transportation, treatment, storage, and disposal of hazardous wastes must be met.	Handling of hazardous wastes	COMAR 26.13.01 through COMAR 26.13.04, Annotated Code of Maryland Title 7	Applicable	Any hazardous waste found during site remediation will be disposed of according to regulations. Any residues or by-products from treatment systems that are hazardous must be disposed of properly.
Stormwater Management					
Design and construction	Regulations require the design and construction of a system necessary to control stormwater.	Design and construction activities	COMAR 26.17.02	Applicable	The remedial action will incorporate measures to control and manage stormwater as necessary.
Erosion and Sediment Control					
Land clearing, grading, and earth disturbances	Regulations require the preparation and implementation of a plan to control erosion and sediment for activities involving land clearing, and grading and earth disturbances. Erosion and sediment control criteria are also established.	Land clearing, grading, and earth disturbances	COMAR 26.17.01	Applicable	The remedial action will incorporate the standards required for clearing, grading, and other earth disturbances, including compliance with county and municipal erosion and sediment control ordinances, and the Commission's erosion- and sedimentation-control regulations.

Table B-3
Action-Specific ARARs
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Maryland Drinking Water Law					
Actions that affect state drinking water	Ensures that the State has the primary enforcement responsibility for drinking water standards under the Federal Safe Drinking Water Act.	Action causing pollution of drinking water supply	COMAR 9.04, Parts 401-413	Applicable	This regulation may be an ARAR for the Lab Area if activities that affect water quality are conducted.
Maryland Tidal Wetland Act					
Tidal Wetlands	Requirements for filling, construction, and dregding of open water and vegetated wetlans and marsh establishment. Permit requirements for marsh establishment.	Permitting process for marsh establishment	COMAR 26.24	Applicable	Compliance for disturbance and establishment of a tidal wetland.
Occupational, Industrial, and Residential Hazards					
Action that will generate noise	Limits set on the levels of noise must be met; these limits are protective of the health, welfare, and property of the people in the State of Maryland. The maximum permitted levels for construction activities may not exceed 90 dBA during the day and 75 dBA during night.	Action that will generate noise	COMAR 26.02.03.02A (2) and B(2), COMAR 26.02.03.02.03A, Annotated Code of Maryland Title 3	Applicable	During site remediation work, the maximum allowable noise levels will not be exceeded at site boundaries.
Air Quality					
Actions that involve emissions to air	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities may emit particulate matter into the ambient air. Remedial activities must follow regulations.	Actions that involve emissions to air above specific limits.	COMAR 26.11	Applicable	May apply to earthwork activities that potentially generate particulate emissions.

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Specific potential ARARs are addressed in the table below each heading.
Acronyms used in the table:

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
DOT - U.S. Department of Transportation
EPA - U.S. Environmental Protection Agency

NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered
USC - United States Code

Appendix C
Proposed Site Remediation Goals for the Lab Area – Technical Memorandum

Proposed Site Remediation Goals for the Lab Area Focused Feasibility Study, Naval Support Facility, Indian Head

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DATE: May 29, 2009 (Rev. 2)

This technical memorandum discusses the procedures used to calculate the human health risk-based and ecological risk-based preliminary remediation goals (PRGs) in support of the Focused Feasibility Study (FFS) for the Lab Area at Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland. This memorandum also describes the proposed site remediation goals (SRGs) and the contaminants of concern (COCs) that will require remediation at the Lab Area.

The technical approach described in this memorandum has been modified from the March 20, 2009 version to incorporate the U.S. Environmental Protection Agency's (EPA) comments on April 7, 2009 and discussion with the Indian Head Installation Restoration Team (IHIRT) on a conference call held on May 4 and June 4, 2009.

Background

The Lab Area was investigated as two subareas during the remedial investigation (RI) — the Upland Area and the downgradient Wetland Area (CH2M HILL, 2004). As part of the RI, CH2M HILL conducted human health and screening ecological risk assessments. Following the RI, a baseline ecological risk assessment (BERA) was conducted for the Upland Area. The BERA concluded that under the baseline condition, unacceptable ecological risks do not exist. The overall conclusion for the Upland Area was that risks were driven by human health concerns. In the Wetland Area, the RI concluded that risks were driven by both human health and ecological risks. In 2003, the Indian Head Installation Restoration Team (IHIRT) agreed that a BERA was not warranted for the downgradient area because it will be excavated using literature-based remediation goals. In 2004, CH2M HILL initiated an Engineering Evaluation/Cost Analysis (EE/CA) for the Lab Area. The EE/CA effort, however, was put on hold because of a continuing source of unabated lead contamination from Buildings 101 and 102 in the Upland Area to the Wetland Area. Without first performing the lead abatement, a removal action in the Wetland Area would have resulted in recontamination of the restored wetland sediment from the Upland Area lead. Since that time, Building 103 has been abated for lead while Building 102 is awaiting lead abatement. In 2008, the IHIRT directed CH2M HILL to proceed with the FFS for the Lab Area, with the assumption that the source of lead contamination has been abated.

Human-Health Risk-Based PRGs

The following subsections provide a summary of the assumptions and results of the PRGs calculation. The equations, assumptions, and calculation of the human health risk-based PRGs are presented in detail in the Attachment 1.

Identification of COCs and Receptors

The COCs in surface soil and subsurface soil, as documented in the baseline human health risk assessment (HHRA) (CH2M HILL, 2004) were as follows:

- Mercury and lead in surface soil in the Upland Area
- Mercury and lead in subsurface soil in the Upland Area
- Arsenic in sediment in the Wetland Area

PRG Calculation

Human health risk-based PRGs were calculated for mercury and lead in soil and arsenic in sediment.

Mercury

Risk-based PRGs for mercury in soil were calculated for six receptors: child resident, adult resident, construction worker, industrial worker, child recreator, and adult recreator. For each receptor, PRGs were calculated to account for the three forms of mercury speciation in soil: elemental, inorganic salts, and methyl mercury (organic form).

The presence of two forms of mercury (elemental and methyl mercury) in soil at the Lab Area has been confirmed from two sources: (1) the results of the surface soil sample collected as part of the BERA (CH2M HILL, 2006) and (2) observation and recovery of elemental mercury during the industrial sewer pipeline repair. As part of the BERA, 10 surface soil samples were analyzed for methyl mercury and total mercury. The results indicated that the ratio of methyl mercury to total mercury ranged from 1% and 56%, with an average of 22%. NSF-IH[1] indicated that approximately 0.5 ounce of elemental mercury was recovered from the pipe during the terracotta pipe repair in Building 103 circa 2007 and Building 600 in March 2009. Based on the information from these two sources, and the assumption that some of the mercury is also in the form of inorganic salts, the following four mercury speciation scenarios were developed to recalculate the PRGs for the six receptors noted above:

- Scenario 1: 50% of total mercury present as methyl mercury (O), 25% of total mercury present as elemental form (E), and 25% of total mercury present as inorganic salts (I)

[1] A phone call conversation with Jim Humphreys of NSF-IH on 4/27/09 and Jim Humphrey's email dated 4/29/09

- Scenario 2: 50% O, 50% E, and 0% I
- Scenario 3: 22% O, 39% E, and 39% I
- Scenario 4: 22% O, 78% E, and 0% I

The PRG for each receptor represents a combined value of the PRGs for all the mercury forms, as described in the equation below.

$$PRG_{Hg} = \left(PRG_{inorgHg} \times F_{inorgHg}\right) + \left(PRG_{elemHg} \times F_{elemHg}\right) + \left(PRG_{methylHg} \times F_{methylHg}\right)$$

Where:

PRG_{Hg} = Preliminary remediation goal for mercury (mg/kg)

$PRG_{inorgHg}$ = PRG for inorganic form of mercury (mg/kg)

$F_{inorgHg}$ = Fraction of mercury in inorganic form

PRG_{elemHg} = PRG for elemental form of mercury (mg/kg)

F_{elemHg} = Fraction of mercury in elemental form

$PRG_{methylHg}$ = PRG for methyl form of mercury (mg/kg)

$F_{methylHg}$ = Fraction of mercury in methyl form

The risk-based PRGs for the inorganic and methyl forms of mercury were calculated using the following equation:

$$PRG_{Hgx} = \frac{THI \times BW \times ATn}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IRS}{10^6 \frac{mg}{kg}}\right) + \left(\frac{1}{RfD_d} \times SA \times AF \times ABS \times \frac{1}{10^6 \frac{mg}{kg}}\right)\right]}$$

Where:

PRG_{Hgx} = Preliminary remediation goal for form of mercury "x" (mg/kg)

THI = Target hazard index (unitless)

BW = Body weight (kg)

ATn = Averaging time, noncarcinogenic (days)

ED = Exposure duration (years)

EF = Exposure frequency (days/year)

RfD_o = oral noncancer reference dose (mg/kg-day)

IRS = Soil ingestion rate (mg/day)

RfD_d = dermal noncancer reference dose (mg/kg-day)

SA = Skin surface area (cm^2)

AF = Soil to skin adherence factor (mg/cm^2-day)

ABS = absorption factor (unitless)

The risk-based PRGs for the elemental form of mercury were calculated using the following equation:

$$PRG_{ElemHg} = \frac{THI \times ATn}{ED \times EF \times \left[\frac{1}{RfC_o} \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)\right]}$$

Where:

PRG_{ElemHg} = Preliminary remediation goal for elemental mercury (mg/kg)

THI = Target hazard index (unitless)

ATn = Averaging time, noncarcinogenic (days)

ED = Exposure duration (years)

EF = Exposure frequency (days/year)

RfC = inhalation reference concentration (mg/m^3)

VF = volatilization factor (m^3/kg)

PEF = particulate emission factor (m^3/kg)

The PRG calculations and values for the surface and subsurface soils are the same because the same exposure factors were used to calculate intake for both soil horizons. It was assumed that in the future, the current subsurface soil could be redistributed during construction and be present at the surface. Table 1 shows the soil PRG values for all six receptors under the four mercury speciation scenarios. Values used for the input parameters for each of the receptors are shown on Tables A-2 through A-6.

TABLE 1
Mercury Human Health Risk-Based PRGs Based on Receptor and Mercury Speciation Scenarios
Proposed SRGs for Lab Area FFS
NSF-IH, Indian Head, Maryland

Receptor	PRGs (mg/kg)			
	Scenario 1 25% E, 25% I, and 50% O	**Scenario 2** 50% E, 0% I, and 50% O	**Scenario 3** 39% E, 39% I, and 22% O	**Scenario 4** 78% E, 0% I, and 22% O
Child Resident	11	11	13	12
Adult Resident	73	42	75	26
Construction Worker	27	20	31	19
Industrial Worker	92	57	90	36
Child Recreator	77	71	91	82
Adult Recreator	494	281	505	174

Note:
All PRGs are based on HI = 1
E – elemental mercury
I – inorganic forms of mercury
O – methyl mercury

Due to the extensive network of underground terra cotta pipes that will be left in place and the potential for residual mercury to remain in those pipes, future digging, and thus construction activities, will be limited in the future. Based on the site condition, the most realistic future site receptor with the most conservative exposure to mercury in the surface soil would be the construction workers.

Arsenic

The PRGs for the recreational adult and recreational child exposed to arsenic in sediment in the Wetland Area via incidental ingestion and dermal contact were calculated:

For noncarcinogenic effects, the PRG was calculated based on the equation below.

$$PRG_{As} = \frac{THI \times BW \times ATn}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IRS}{10^6 \frac{mg}{kg}}\right) + \left(\frac{1}{RfD_d} \times SA \times AF \times ABS \times \frac{1}{10^6 \frac{mg}{kg}}\right)\right]}$$

Where:

PRG_{As} = Preliminary remediation goal for arsenic (mg/kg)
THI = Target hazard index (unitless)
BW = Body weight (kg)
ATn = Averaging time, noncarcinogenic (days)
ED = Exposure duration (years)
EF = Exposure frequency (days/year)
RfDo = oral noncancer reference dose (mg/kg-day)
IRS = Sediment ingestion rate (mg/day)

RfDd = dermal noncancer reference dose (mg/kg-day)
SA = Skin surface area (cm^2)
AF = Sediment to skin adherence factor (mg/cm^2-day)
ABS = absorption factor (unitless)

For carcinogenic endpoints, the PRG was calculated based on the equation below.

$$PRG_{As} = \frac{TR \times BW \times ATc}{ED \times EF \times \left[\left(CSF_o \times \frac{IRS}{10^6 \frac{mg}{kg}} \right) + \left(CSF_d \times SA \times AF \times ABS \times \frac{1}{10^6 \frac{mg}{kg}} \right) \right]}$$

Where:

PRG_{As} = Preliminary remediation goal for arsenic (mg/kg)
TR = Target cancer risk (unitless)
ATc = Averaging time, carcinogenic (days)
CSF_o = Cancer slope factor (1/mg/kg-day)
CSF_d = Cancer slope factor (1/mg/kg-day)

Values used for the input parameters for both of the receptors are shown on Tables A-7 through A-10. The arsenic sediment PRG for the adult recreator is 34 mg/day, based on a cancer risk of 10^{-4}, the lower of the PRG based on noncancer effects and cancer endpoints. The arsenic sediment PRG for the child recreator is 84 mg/kg, based on a target hazard index of 1, the lower of the PRG based on noncancer effects and cancer endpoints.

Lead

Because a reference dose (RfD) value is not available for lead, it was not possible to calculate a noncancer hazard or PRG, as is done for other chemicals. An RfD is typically derived from a threshold concentration, which is a concentration below which no adverse effects have been observed. Evidence indicates that very low exposure to lead can result in adverse health effects (neurological effects) to children (EPA, 2009). The toxicokinetics (absorption, distribution, metabolism, and excretion from the body) of lead are well understood, and lead is regulated based on blood lead concentrations (EPA, 2009). EPA has concluded that childhood blood lead concentrations at or above 10 micrograms of lead per deciliter of blood (µg/dL) pose risks to children. The EPA goal for contaminated sites is to limit the probability of a child's blood lead concentration exceeding 10 µg/dL to 5 percent or less after cleanup.

Blood lead concentrations were predicted, along with the probability of a child's blood lead concentration exceeding 10ug/L, using a model that considers lead exposure and toxicokinetics in a receptor. For a child, the Integrated Exposure Uptake Biokinetic Model (IEUBK) model was used, and for a fetus of an adult industrial worker, the adult lead methodology (ALM) was used. The ALM was developed to calculate levels of lead such that the fetus of a pregnant female worker would not have an unsafe concentration of lead in blood. The ALM model assumes that a PRG protective of a fetus will also be protective of male or female adult workers. These models were also used to calculate the PRGs for lead. Based on the IEUBK model, the PRG for soil for residential site use, based on a child resident, is 400 mg/kg. The ALM was used to derive the lead PRG for industrial site. The ALM was run using the default input values for Northeast/All population from the

National Health and Nutrition Evaluation Survey III Study (EPA, 2002). The PRG for lead in soil based on industrial use of the site is 1,092 mg/kg.

Ecological Risk-Based PRGs

In 2003, the IHIRT agreed that given the relatively high concentrations of mercury in the wetland sediment, a sediment removal action in lieu of a BERA was the best course of action for the Wetland Area and that a BERA should be conducted for the Upland Area. Furthermore, the PRGs for COPCs in the sediment would be developed from literature-based values to be approved by the Biological Technical Assistance Group. A technical memorandum dated March 9, 2004 was prepared to document the literature-based PRGs for consideration in the FFS.

As part of the RI, potential risks were identified in the screening ecological risk assessment (SERA) to wetland receptors (water column invertebrates, amphibians, and omnivorous wetland mammals). These risks will be mitigated with removal of the contaminated sediment and restoration of the wetland. The BERA investigation was completed in May 2006 for the Upland Area. The results indicated that the concentrations of the COPCs identified for terrestrial ecological receptors, including soil invertebrates, insectivorous birds, and omnivorous mammals, do not pose unacceptable risks.

The PRGs identified in the March 9, 2004 technical memorandum were conservative literature-based values. Although site-specific risks were not identified for the Wetland Area as part of the BERA, the findings of the BERA provide additional information that could aid in risk management for the wetland. The COPCs in the Upland Area, including mercury, were found to not pose unacceptable risks. Mercury concentrations in the BERA investigation ranged from 0.75 to 127 mg/kg in surface soil. The results of the toxicity testing and bioaccumulation studies demonstrated that mercury is not present in a bioavailable and toxic form and was not bioaccumulating in the food chain to levels that would pose unacceptable risks. It is possible that the percentage of mercury that is present in organic form (methlymercury) and bioavailable may be greater in the wetland sediment that it is in the upland soils. However, any remedial goal should account for the possible transport of some mercury from the upland soil to the Wetland Area though soil erosion. An additional consideration for risk management of the Wetland Area is the limited habitat value of the wetland for benthic invertebrates. There is very little aquatic habitat present, other than the small drainage channel through the center of the wetland. Most of the wetland consists of emergent wetland vegetation with saturated soils, which provides limited habitat for benthic invertebrates.

Based on these considerations, the selected ecological risk-based PRG should be protective of the benthic community and semi-aquatic mammals, such as raccoons, that may forage in the wetland. The proposed mercury PRG is 1.06 mg/kg, which is a consensus-based probable effect concentration for freshwater sediments (Ingersoll et al., 2000), would be protective of both receptors.

Site Remediation Goals and COCs Requiring Removal

For each COC, the proposed site remediation goal (SRG) was selected based on the human health or ecological risk-based PRG and the facility-wide background concentration if available. If the facility-wide background concentration was higher than the risk-based PRG, the background concentration was selected as the SRG. Table 2 summarizes the selection of the proposed SRGs for use in the FFS.

The SRGs were then used to identify which COCs will warrant a removal action, by comparing the SRG of each COC to the maximum detected concentration. If the COC maximum detected concentration exceeds its SRG, a removal action is warranted for the COC. Table 3 summarizes the process for identifying the COCs that will require removal action.

TABLE 2
Summary of Proposed SRGs
Proposed SRGs for the Lab Area FFS
NSF-IH, Indian Head, Maryland

COC	Medium	Facility-wide Background Concentration (mg/kg)[1,2]	Human Health Risk-Based PRGs (mg/kg)		Eco Risk-Based PRG (mg/kg)
			Residential	Industrial	
Mercury	Surface Soil	0.06	11[3]	**19**	NR
	Wetland Sediment	0.2	NR	NR	**1.06**
Arsenic	Wetland Sediment	10.6	**34**	NR	NR
Lead	Surface Soil	21.7	**400**	1,092	NR

Note:
NR – No Risk

Bold font indicates the proposed SRG

* - Subsurface soil present at the surface to be exposed to future receptors

1 The surface soil facility background concentrations were obtained from the *Background Soil Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Maryland* prepared by Tetratech NUS in February, 2002

2 The wetland sediment facility background concentration was obtained from the *Background Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Maryland* prepared by Brown and Root Environmental in December, 1997.

3 Representing the lowest value among the adult and child residents and the adult and child recreators.

TABLE 3
COCs Requiring Removal
Proposed SRGs for the Lab Area FFS
NSF-IH, Indian Head, Maryland

COC	Medium	Max Detect	FOD	Facility Background	# of Background Exceedances	Proposed SRG	Basis	# of SRG Exceedances	Require Removal?
Mercury	Surface Soil	962	76/81	0.06	76/81	19	Non-carcinogenic risk to construction workers, THI = 1	21/81	Yes
	Wetland Sediment	24.5	2/2	0.2	2/2	1.06	Probable effect concentration for freshwater sediments	2/2	Yes
Arsenic	Wetland Sediment	20.2	2/2	10.6	1/2	34	Carcinogenic risk to future adult recreator, TR = 10^{-4}	0/2	No
Lead	Surface Soil	31,200	82/82	21.7	75/82	400	Future child resident, IEUBK Model	23/82	Yes

Note: All concentrations are in mg/kg

References

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EPA, 2008. *Regional Screening Levels for Contaminants at Superfund Sites*. September.

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Attachment 1
Human Health Risk-Based PRG Calculation

Table A-1

Human Health Risk-Based Preliminary Remediation Goals

Soil

Child Residential Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	Noncarcinogen PRG HQ = 0.5 (mg/kg)	Noncarcinogen PRG HQ = 1 (mg/kg)	Noncarcinogen PRG PRG (mg/kg)	Noncarcinogen PRG Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	6.7E-01	2.7E-01	1.7E+00	8.4E+00	1.7E+01	**1.7E+01**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	2.0E+00	5.6E-02	7.6E-01	3.8E+00	7.6E+00	**7.6E+00**	1
Mercury, elemental			3.0E-04	Neurological				1.3E+00	6.7E+00	1.3E+01	**1.3E+01**	1
Mercury combined								1.2E+00	6.1E+00	1.2E+01		

Noncarcinogenic calculations:

Soil PRG (ing and dermal) = (mg/kg)

$$\text{Soil PRG} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

Soil PRG (inhalation) =

$$\frac{\text{Target HQ} \times ATn}{EF \times ED \times (1/RfC \times (1/VF + 1/PEF))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm + Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IRS - Ingestion rate (mg/day)	200
SA - Skin surface area (cm^2)	2,800
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.2
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	calc (Table A-1a)
Fi - Fraction of mercury in inorganic form	0.0E+00
Fm - Fraction of mercury in methyl form	2.2E-01
Fe - Fraction of mercury in elemental form	7.8E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.

NA - Not available/Not applicable

Table A-1a
Occurrence, Distribution and Selection of Chemicals of Potential Concern
Calculation of Generic Chemical Specific VF Factors
Lab Area, NSWC Indian Head

Chemical	Diffusivity in Air (D_i) (cm^2/s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D_w) (cm^2/s)	Soil Organic Carbon Partition Coeff. (K_{oc}) (cm^3/g)	Soil Water Partition Coeff. ($K_d = K_{oc} \times F_{oc}$) ($g/cm^3$)	Solubility in Water (S) (mg/L)	Apparent Diffusivity (D_A) (cm^2/s)	Volatilization Factor (VF) (m^3/kg)
Mercury	3.07E-02	4.67E-01	6.30E-06		5.20E01		1.46E-05	4.29E+04

Volatilization factor (VF) =
(m^3/kg)

$$VF = \frac{Q/C * (3.14 * D_A * T)^{1/2} * 10^{-4}\ m^2/cm^2}{2 * r_b * D_A}$$

Apparent Diffusivity (D_A) =
(cm^2/s)

$$D_A = \frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}$$

Parameters	Values
Q/C - Inverse of the mean concentration at the center of a 0.5-acre-square source for Philadelphia (g/m^2-s per kg/m^3)	90.24
T - Exposure interval(s)	9.5E+08
r_b - Soil bulk density (g/cm^3)	1.5
Q_a - Air-filled soil porosity (L_{air}/L_{water}) = n - Q_w	0.28
n - Total soil porosity (Lpore/Lsoil) = 1 - (r_b/r_s)	0.43
Q_w - Water-filled soil porosity (Lwater/Lsoil)	0.15
r_s - Soil particle density (g/cm^3)	2.65
f_{oc} - fraction organic carbon in soil (g/g)	0.006

Chemical and physical properties from USEPA, 1996, *Soil Screening Guidance: User's Guide,* EPA/540/R-96/018.

Table A-2
Human Health Risk-Based Preliminary Remediation Goals
Soil
Adult Residential Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	3.3E-01	1.9E-01	1.4E+01	7.0E+01	1.4E+02	**1.4E+02**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	1.0E+00	4.0E-02	7.0E+00	3.5E+01	7.0E+01	**7.0E+01**	1
Mercury, elemental			3.0E-04	Neurological				1.3E+00	6.7E+00	1.3E+01	**1.3E+01**	1
Mercury combined								2.6E+00	1.3E+01	2.6E+01		

Noncarcinogenic calculations:

$$\textbf{Soil PRG (ing and dermal) (mg/kg)} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

$$\textbf{Soil PRG (inhalation)} = \frac{\text{Target HQ} \times ATn}{EF \times ED \times (1/RfC \times (1/VF + 1/PEF))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm + Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8,760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	24
IRS - Ingestion rate (mg/day)	100
SA - Skin surface area (cm^2)	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.1
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	chemical specific
Fi - Fraction of mercury in inorganic form	0.0E+00
Fm - Fraction of mercury in methyl form	2.2E-01
Fe - Fraction of mercury in elemental form	7.8E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.
NA - Not available/Not applicable

Table A-3
Human Health Risk-Based Preliminary Remediation Goals
Soil
Construction Worker Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	1.6E+00	4.7E-01	4.9E+00	2.5E+01	4.9E+01	**4.9E+01**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	4.8E+00	9.9E-02	2.1E+00	1.0E+01	2.1E+01	**2.1E+01**	1
Mercury, elemental			3.0E-04	Neurological				1.9E+00	9.4E+00	1.9E+01	**1.9E+01**	1
Mercury combined								1.9E+00	9.6E+00	1.9E+01		

Noncarcinogenic calculations:

$$\textbf{Soil PRG (ing and dermal) (mg/kg)} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

$$\textbf{Soil PRG (inhalation)} = \frac{\text{Target HQ} \times ATn}{EF \times ED \times (1/RfC \times (1/VF + 1/PEF))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm
+ Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	365
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	250
ED - Exposure duration (year)	1
IRS - Ingestion rate (mg/day)	480
SA - Skin surface area (cm^2)	3,300
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.3
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	chemical specific
Fi - Fraction of mercury in inorganic form	0.0E+00
Fm - Fraction of mercury in methyl form	2.2E-01
Fe - Fraction of mercury in elemental form	7.8E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.
NA - Not available/Not applicable

Table A-4
Human Health Risk-Based Preliminary Remediation Goals
Soil
Industrial Worker Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	3.3E-01	3.1E-01	1.6E+01	7.9E+01	1.6E+02	**1.6E+02**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	1.0E+00	6.6E-02	9.6E+00	4.8E+01	9.6E+01	**9.6E+01**	1
Mercury, elemental			3.0E-04	Neurological				1.9E+00	9.4E+00	1.9E+01	**1.9E+01**	1
Mercury combined								9.2E+00	4.6E+01	9.2E+01		

Noncarcinogenic calculations:

$$\textbf{Soil PRG (ing and dermal)} = \frac{\text{Target HQ} \times \text{BW} \times \text{AT}_n}{\text{EF} \times \text{ED} \times (\text{An} + \text{Bn})} \quad \textbf{(mg/kg)}$$

An = $1/\text{RfDo} \times \text{IRS}/10^6$ mg/kg

Bn = $1/\text{RfDd} \times \text{SA} \times \text{AF} \times \text{ABS} \times 1/10^6$ mg/kg

$$\textbf{Soil PRG (inhalation)} = \frac{\text{Target HQ} \times \text{ATn}}{\text{EF} \times \text{ED} \times (1/\text{RfC} \times (1/\text{VF} + 1/\text{PEF}))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm
+ Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	9,125
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	250
ED - Exposure duration (year)	25
IRS - Ingestion rate (mg/day)	100
SA - Skin surface area (cm^2)	3,300
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.2
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	chemical specific
Fi - Fraction of mercury in inorganic form	2.5E-01
Fm - Fraction of mercury in methyl form	5.0E-01
Fe - Fraction of mercury in elemental form	2.5E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.
NA - Not available/Not applicable

Table A-5
Human Health Risk-Based Preliminary Remediation Goals
Soil
Child Recreator Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m³)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	6.7E-01	2.7E-01	1.1E+01	5.7E+01	1.1E+02	**1.1E+02**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	2.0E+00	5.6E-02	5.1E+00	2.6E+01	5.1E+01	**5.1E+01**	1
Mercury, elemental			3.0E-04	Neurological				9.1E+00	4.5E+01	9.1E+01	**9.1E+01**	1
Mercury combined								7.7E+00	3.8E+01	7.7E+01		

Noncarcinogenic calculations:

$$\textbf{Soil PRG (ing and dermal) (mg/kg)} = \frac{\text{Target HQ x BW x AT}_n}{\text{EF x ED x (An + Bn)}}$$

An = $1/\text{RfDo x IRS}/10^6$ mg/kg

Bn = $1/\text{RfDd x SA x AF x ABS x }1/10^6$ mg/kg

$$\textbf{Soil PRG (inhalation)} = \frac{\text{Target HQ x ATn}}{\text{EF x ED x (1/RfC x (1/VF + 1/PEF))}}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm + Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,195
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	52
ED - Exposure duration (year)	6
IRS - Ingestion rate (mg/day)	200
SA - Skin surface area (cm^2)	2,800
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.2
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	chemical specific
Fi - Fraction of mercury in inorganic form	2.5E-01
Fm - Fraction of mercury in methyl form	5.0E-01
Fe - Fraction of mercury in elemental form	2.5E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.
NA - Not available/Not applicable

Table A-6
Human Health Risk-Based Preliminary Remediation Goals
Soil
Adult Recreator Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Mercury, Inorganic	3.0E-04	2.1E-05		Immune System	1.0E-02	3.3E-01	1.9E-01	9.4E+01	4.7E+02	9.4E+02	**9.4E+02**	1
Mercury, Methyl	1.0E-04	1.0E-04		Immune System	1.0E-02	1.0E+00	4.0E-02	4.7E+01	2.4E+02	4.7E+02	**4.7E+02**	1
Mercury, elemental			3.0E-04	Neurological				9.0E+00	4.5E+01	9.0E+01	**9.0E+01**	1
Mercury combined								1.7E+01	8.7E+01	1.7E+02		

Noncarcinogenic calculations:

$$\textbf{Soil PRG (ing and dermal) (mg/kg)} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

$$\textbf{Soil PRG (inhalation)} = \frac{\text{Target HQ} \times ATn}{EF \times ED \times (1/RfC \times (1/VF + 1/PEF))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm + Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8,760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	52
ED - Exposure duration (year)	24
IRS - Ingestion rate (mg/day)	100
SA - Skin surface area (cm^2)	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.1
ABS - Absorption Factor (unitless)	chemical specific
PEF - Particulate Emission Factor (m^3/kg)	1.32E+09
VF - Volatilization Factor (m^3/kg)	chemical specific
Fi - Fraction of mercury in inorganic form	0.0E+00
Fm - Fraction of mercury in methyl form	2.2E-01
Fe - Fraction of mercury in elemental form	7.8E-01

1 Target HQ calculated so that total HQ for a target organ does not exceed 1. 1.0E+00

NA - Not available/Not applicable

Table A-7
Human Health Risk-Based Preliminary Remediation Goals
Sediment
Child Recreator Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Arsenic	3.0E-04	3.0E-04		Skin/Vascular	3.0E-02	3.3E-01	9.2E-01	8.4E+00	4.2E+01	8.4E+01	**8.4E+01**	1

Noncarcinogenic calculations:

$$\text{Soil PRG (ing and dermal) (mg/kg)} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

EXPOSURE ASSUMPTIONS		
BW - Body weight (kilograms)	15	
ATnc - Averaging time for noncarcinogens (days)	2,190	
ATc - Averaging time for carcinogens (days)	25,550	
EF - Exposure frequency (days/year)	52	
ED - Exposure duration (year)	6	
IRS - Ingestion rate (mg/day)	100	
SA - Skin surface area (cm^2)	2,800	
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	3.3	children playing in wet soil
ABS - Absorption Factor (unitless)	chemical specific	

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.

NA - Not available/Not applicable

Table A-8
Human Health Risk-Based Preliminary Remediation Goals
Sediment
Adult Recreator Scenario (Noncarcinogenic)

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhal RfC (mg/m^3)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Arsenic	3.0E-04	3.0E-04		Skin/Vascular	3.0E-02	1.7E-01	7.4E+00	6.5E+00	3.2E+01	6.5E+01	**6.5E+01**	1

Noncarcinogenic calculations:

Soil PRG (ing and dermal) = (mg/kg)
$$\frac{\text{Target HQ} \times \text{BW} \times \text{AT}_n}{\text{EF} \times \text{ED} \times (\text{An} + \text{Bn})}$$

An = $1/\text{RfDo} \times \text{IRS}/10^6$ mg/kg

Bn = $1/\text{RfDd} \times \text{SA} \times \text{AF} \times \text{ABS} \times 1/10^6$ mg/kg

Soil PRG (inhalation) =
$$\frac{\text{Target HQ} \times \text{ATn}}{\text{EF} \times \text{ED} \times (1/\text{RfC} \times (1/\text{VF} + 1/\text{PEF}))}$$

Soil PRG = Soil PRG- Mercury inorganic x Fi + Soil PRG - Mercury Methyl x Fm + Soil PRG-Methyl elemental x Fe

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	10,950
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	52
ED - Exposure duration (year)	30
IRS - Ingestion rate (mg/day)	50
SA - Skin surface area (cm^2)	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	13.0
ABS - Absorption Factor (unitless)	chemical specific

pipe layers wet soil

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.
NA - Not available/Not applicable

Table A-9

Human Health Risk-Based Preliminary Remediation Goals

Sediment

Child Recreator Scenario (Carcinogenic)

Chemical	Oral Slope Factor (CSFo) (kg-day/mg)	Dermal Slope Factor (CSFd) (kg-day/mg)	Absorption Factor (ABS) (unitless)	Ac	Bc	Carcinogen PRG		
						Risk = 1E-06 (mg/kg)	Risk = 1E-05 (mg/kg)	Risk = 1E-04 (mg/kg)
Arsenic	1.5E+00	1.5E+00	3.0E-02	1.5E-04	4.2E-04	2.2E+00	2.2E+01	2.2E+02

Carcinogen calculations:

$$\text{Soil RBC (mg/kg)} = \frac{\text{TR} \times \text{BW} \times \text{AT}_c}{\text{EF} \times \text{ED} \times (\text{Ac} + \text{Bc})}$$

Ac = CSFo x IRS/10^6 mg/kg

Bc = CSFd x SSA x AF x ABS x 1/10^6 mg/kg

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	52
ED - Exposure duration (year)	6
IRS - Ingestion rate (mg/day)	100
SSA - Skin surface area (m^3)	2,800
AF - Soil to Skin Adherence Factor (mg/cm^2)	3.3
ABS - Absorption Factor (unitless)	chemical specific

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.

NA - Not available/Not applicable

Table A-10
Human Health Risk-Based Preliminary Remediation Goals
Sediment
Adult Recreator Scenario (Carcinogenic)

Chemical	Oral Slope Factor (CSFo) (kg-day/mg)	Dermal Slope Factor (CSFd) (kg-day/mg)	Absorption Factor (ABS) (unitless)	Ac	Bc	Carcinogen PRG Risk = 1E-06 (mg/kg)	Risk = 1E-05 (mg/kg)	Risk = 1E-04 (mg/kg)
Arsenic	1.5E+00	1.5E+00	3.0E-02	7.5E-05	3.3E-03	3.4E-01	3.4E+00	3.4E+01

Carcinogen calculations:

$$\textbf{Soil RBC (mg/kg)} = \frac{TR \times BW \times AT_c}{EF \times ED \times (Ac + Bc)}$$

Ac = CSFo x IRS/10^6 mg/kg

Bc = CSFd x SSA x AF x ABS x 1/10^6 mg/kg

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	10,950
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	52
ED - Exposure duration (year)	30
IRS - Ingestion rate (mg/day)	50
SSA - Skin surface area (m^3)	5,700
AF - Soil to Skin Adherence Factor (mg/cm^2)	13.0
ABS - Absorption Factor (unitless)	chemical specific

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.

NA - Not available/Not applicable

Table A-11

Lead Preliminary Remediation Goal

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/05

Exposure Variable	Description of Exposure Variable	Units	Region OR Ethnic GSDi and PbBo Data from NHANES III Analysis
			Northeast/All Population
$PbB_{fetal, 0.95}$	95th percentile PbB in fetus	ug/dL	10
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	2.0
PbB_0	Baseline PbB	ug/dL	2.0
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PRG		**ppm**	**1,092**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same PRG.

Appendix D
Detailed Cost Estimate

Appendix D
Remedial Alternatives Cost Summary*
Lab Area Focused Feasibility Study
NSF-IH, Indian Head, Maryland

Remedial Alternatives	Construction Time (weeks)	Operation Time (years)	2007/2008 Capital Cost	2007/2008 Lifetime O&M	Lifetime Present Worth O&M	Total Present Worth
Solid Waste, Soil, and Groundwater in Area A						
2 Institutional Controls	N/A	30	$ -	$ 171,600	$ 96,000	**$ 96,000**
3 Excavation and Off-Site Disposal	3	N/A	$ 378,200	$ 22,100	$ 19,400	**$ 397,600**

Notes:
* Does not include cost for MPPEH management, transporation, storage, handling, or treatment if needed.
All costs are roundup by 2 significant digits

SOIL REMEDIAL ALTERNATIVE 2 Institutional Controls	LOCATION: Lab Area	MEDIA: Solid Waste and Contaminated Soil	Construction time: N/A Operation time: 30 years

DESCRIPTION OF ALTERNATIVE:

Institutional controls will be applied to limit exposure to soil and restrict future land use.

ASSUMPTIONS:

1) Five-year reviews are required for replacement of signs, inspection, and reporting.

2) Sources of costs are 2007 RS Means Site Work & Landscape Cost Data, 2004 RS Means Environmental Remediation Cost Data - Unit Price, vendor quotes, and CH2M HILL rates based on similar projects.

3) Cost escalation factor to adjust 2007 cost to 2009 cost: 4% (applied to the total capital cost)

Cost Component	Qty	Unit	Cost Source	Estimated Activity Duration (day)	Labor Unit Cost	Labor Total Cost	Equipment Unit Cost	Equipment Total Cost	Material Unit Cost	Material Total Cost	Subcontractor	Total Cost
CAPITAL COSTS												
Submittal												**$18,755.50**
ICs Plan (draft and final)	150	hours	CH2M HILL Rates		$100.00	$15,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$15,000.00
Survey of IC boundaries	1.00	day	M02 21 13 13 0400	1	$897.50	$897.50	$58.00	$58.00	$0.00	$0.00	$0.00	$955.50
Signge	1.00	lump sum	CH2M HILL Rates	1	$1,200.00	$1,200.00	$100.00	$100.00	$1,500.00	$1,500.00	$0.00	$2,800.00
OPERATION & MAINTENANCE AND PERIODIC ACTIVITIES - PER EVENT COST												
Periodic Activities												**$1,200.00**
Biannual inspection	16	hrs	E 99 11 0403 CH2M HILL adjusted		$75.00	$1,200.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,200.00
Five-Year Review												**$10,486.00**
Sign Replacement	7	each	CH2M HILL Rates	1	$150.00	$150.00	$0.00	$0.00	$48.00	$336.00	$0.00	$486.00
Report - Engineer	1	lump sum	CH2M HILL Rates		$10,000.00	$10,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$10,000.00
Site Closure												**$15,000.00**
Report development	1	lump sum	Allowance		$15,000.00	$15,000.00	$0.00		$0.00	$0.00	$0.00	$15,000.00

PRESENT WORTH CALCULATION
REMEDIAL ALTERNATIVE 2 - Institutional Controls

Location:	Lab Area, NSF-IH, Indian Head, Maryland	Construction time:	N/A
Media:	Soil and Solid Waste - Upland and Wetland Area	Operation time:	30 years
		Discount Rate:	4.5%
		O&M Contingency:	Fixed-Price

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
0	$21,642	Capital cost, two biannual field inspections	O&M	1.00	$21,642
1	$2,400	Two biannual field inspections	O&M	1.05	$2,297
2	$2,400	Two biannual field inspections	O&M	1.09	$2,198
3	$2,400	Two biannual field inspections	O&M	1.14	$2,103
4	$2,400	Two biannual field inspections	O&M	1.19	$2,013
5	$12,886	Two biannual field inspections, sign replacement, and five year review	O&M, Periodic	1.25	$10,340
6	$2,400	Two biannual field inspections	O&M	1.30	$1,843
7	$2,400	Two biannual field inspections	O&M	1.36	$1,764
8	$2,400	Two biannual field inspections	O&M	1.42	$1,688
9	$2,400	Two biannual field inspections	O&M	1.49	$1,615
10	$12,886	Two biannual field inspections, sign replacement, and five year review	O&M, Periodic	1.55	$8,298
11	$2,400	Two biannual field inspections	O&M	1.62	$1,479
12	$2,400	Two biannual field inspections	O&M	1.70	$1,415
13	$2,400	Two biannual field inspections	O&M	1.77	$1,354
14	$2,400	Two biannual field inspections	O&M	1.85	$1,296
15	$12,886	Two biannual field inspections, sign replacement, and five year review	O&M, Periodic	1.94	$6,658
16	$2,400	Two biannual field inspections	O&M	2.02	$1,187
17	$2,400	Two biannual field inspections	O&M	2.11	$1,136
18	$2,400	Two biannual field inspections	O&M	2.21	$1,087
19	$2,400	Two biannual field inspections	O&M	2.31	$1,040
20	$12,886	Two biannual field inspections, sign replacement, and five year review	O&M, Periodic	2.41	$5,343
21	$2,400	Two biannual field inspections	O&M	2.52	$952
22	$2,400	Two biannual field inspections	O&M	2.63	$911
23	$2,400	Two biannual field inspections	O&M	2.75	$872
24	$2,400	Two biannual field inspections	O&M	2.88	$834
25	$12,886	Two biannual field inspections, sign replacement, and five year review	O&M, Periodic	3.01	$4,288
26	$2,400	Two biannual field inspections	O&M	3.14	$764
27	$2,400	Two biannual field inspections	O&M	3.28	$731
28	$2,400	Two biannual field inspections	O&M	3.43	$700
29	$2,400	Two biannual field inspections	O&M	3.58	$670
30	$27,886	Two biannual field inspections, sign replacement, five year review, and site closure	O&M, Periodic, Site Closure	3.75	$7,446
CAPITAL COST	**$0**				
2009 Dollar LIFETIME O&M	**$171,558**		**Lifetime Present Worth O&M**		**$95,962**
TOTAL IMPLEMENTATION COST	**$171,558**		**TOTAL PRESENT WORTH**		**$95,962**

SOIL REMEDIAL ALTERNATIVE 3 Excavation, Off-site Disposal, and Wetland Creation	LOCATION: Lab Area NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste and Contaminated Soil	Construction time: 3 weeks Operation time: N/A Post Remediation Monitoring: none

DESCRIPTION OF ALTERNATIVE:

Excavation of soil area of attainment containing contaminated soil; off-site disposal of the excavated material to a permitted landfill; and, creation of wetland.

ASSUMPTIONS:

		SF	CY		
1)	The Upland AA is approx. (Fig 1 FS)	28700	1062.96	0.66 acres	5) There are no munitions within the Lab Area
2)	The Wetland AA is approx. (Fig 1 FS)	15423.17	571.23	0.35 acres	
			2,559	tons (assume bulk density of 1.85 kg/L)	6) Swelling factor: 10%
		Wetland	Upland		7) Area requiring wetlands mitigation 15,423 SF 0.35 acres
3)	Total volume of top soil backfill (6" & 6", wetland & upland):	285.61	531.48	CY	8) Five-year reviews are required for replacement of signs, inspection, and reporting. O&M activities are limited to the care of the created wetland through biannual field inspections and vegetation replanting.
4)	Total volume of earthen material fill (6" and 6", wetland and upland):	285.61	531.48	CY	9) Sources of costs are 2007 RS Means Site Work & Landscape Cost Data, 2004 RS Means Environmental Remediation Cost Data - Unit Price, vendor quotes, and CH2M HILL rates based on similar projects.
					10) Cost escalation factor to adjust 2007 cost to 2009 cost: 4% (applied to the individual cost of Env Rem)

Cost Component	Qty	Unit	Cost Source	Estimated Activity Duration (day)	Labor Unit Cost	Labor Total Cost	Equipment Unit Cost	Equipment Total Cost	Material Unit Cost	Material Total Cost	Subcontractor	Total Cost
CAPITAL COSTS												
Site Preparation				3								**$3,330.70**
Site clearing (dozer light)	1.01	acre	M 31 11 10 10 0020	2	$1,278.69	$1,291.47	$1,073.00	$1,083.73	$0.00	$0.00	$0.00	$2,375.20
Survey	1	days	M02 21 13 13 0400	1	$897.50	$897.50	$58.00	$58.00	$0.00	$0.00	$0.00	$955.50
Excavation and Backfill				10								**$51,145.72**
Excavation, bulk, dozer, piled, 300 HP 50' haul common earth	1,634	CY	M 31 23 16 46 5020 adjusted (4.0 Multiplier per CCI)	1	$1.24	$2,026.40	$3.68	$6,013.82	$0.00	$0.00	$0.00	$8,040.22
Dewatering of Wetland excavated material (assumed - 75% of excavated material)	428	CY	CH2M HILL Estimate (stockpile passive dewatering, mix dry & wet, no free liquids)		$5.75	$2,463.42	$7.50	$3,213.16	$4.00	$1,713.69	$0.00	$7,390.27
Compaction - sheepsfoot, 12" lifts, 4 passes (compact natural soil before backfill)	1,634	CY	M 31 23 23 23 5720	1	$0.16	$261.47	$0.37	$604.65	$0.00	$0.00	$0.00	$866.12
Borrow, loading, and spreading - common earth, shovel, 1CY bucket (6" and 8" thick, wetland and upland)	817	CY	M 31 23 23 15 4000	1	$0.65	$531.11	$1.24	$1,013.20	$8.10	$6,618.48	$0.00	$8,162.79
Compaction - sheepsfoot, 6" lifts, 3 passes (Wetland 6" common earth)	286	CY	M 31 23 23 23 5620	1	$0.24	$68.55	$0.55	$157.09	$0.00	$0.00	$0.00	$225.64
Compaction - sheepsfoot, 12" lifts, 4 passes (Upland 8" common earth)	531	CY	M 31 23 23 23 5720	1	$0.16	$85.04	$0.37	$196.65	$0.00	$0.00	$0.00	$281.69
Borrow, loading, and spreading - top soil, shovel, 1CY bucket (6" and 4" thick, wetland and upland)	817	CY	M 31 23 23 15 7000	1	$0.65	$531.11	$1.24	$1,013.20	$22.00	$17,976.11	$0.00	$19,520.42
Grading - large area (Wetland)	1,714	SY	M 31 22 16 10 0100	1	$0.27	$462.70	$0.25	$428.42	$0.00	$0.00	$0.00	$891.12
Grading - small irregular area (Upland)	3,189	SY	M 31 22 16 10 1050	2	$0.81	$2,583.00	$0.85	$2,710.56	$0.00	$0.00	$0.00	$5,293.56
Compaction - sheepsfoot, 6" lifts, 2 passes (6" and 4" thick, wetland and upland)	817	CY	M 31 23 23 23 5600	1	$0.18	$147.08	$0.40	$326.84	$0.00	$0.00	$0.00	$473.92
Off-site Transportation and Disposal				**Concurrent w/ excavation**								**$227,897.48**
Landfill Fees	2,559	ton	E 33 19 7269		$0.00	$0.00	$0.00	$0.00	$85.80	$219,574.54	$0.00	$219,574.54
Dump Truck Transportation Minimum Charge (16.5 CY travel 23.5 miles)	2,517	miles	E 33 19 0218		$0.00	$0.00	$0.00	$0.00	$1.97	$4,957.81	$0.00	$4,957.81
Loading soil into truck	1,798	CY	E 33 19 0150		$0.67	$1,196.49	$1.21	$2,168.64	$0.00	$0.00	$0.00	$3,365.13
Site Restoration				1								**$2,241.46**
Hydroseeding	44	M.SF	M 32 92 19 13 2400	1	$9.65	$425.79	$5.65	$249.30	$35.50	$1,566.37	$0.00	$2,241.46
Wetlands Mitigation				1								**$8,750.00**
Planting of native wetland species	0.35	acre	Professional Judgment	1	$0.00	$0.00	$0.00	$0.00	$25,000.00	$8,750.00	$0.00	$8,750.00
Construction Oversight												**$26,400.96**
Engineer (P2)	3	weeks	CH2M HILL rates	15	$2,659.20	$7,977.60	$0.00	$0.00	$0.00	$0.00	$0.00	$7,977.60
Site Health and Safety (P2)	3	weeks	CH2M HILL rates	15	$2,659.20	$7,977.60	$0.00	$0.00	$0.00	$0.00	$0.00	$7,977.60
Superintendent (P3)	3	weeks	CH2M HILL rates	15	$3,481.92	$10,445.76	$0.00	$0.00	$0.00	$0.00	$0.00	$10,445.76

SOIL REMEDIAL ALTERNATIVE 3 Excavation, Off-site Disposal, and Wetland Creation	LOCATION: Lab Area NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste and Contaminated Soil	Construction time: 3 weeks Operation time: N/A Post Remediation Monitoring: none

Preconstruction Submittals												**$3,928.07**
Preconstruction survey, design basis, pre-draft, draft, and final design, specifications, and H&S plans	1	lump sum	6% of total construction cost		$3,928.07	$3,928.07	$0.00	$0.00	$0.00	$0.00	$0.00	$3,928.07
General Conditions												**$9,820.18**
Decontamination, temp. facilities, sed. & erosion control, temp. fence, etc.	1	lump sum	15% of total construction cost		$9,820.18	$9,820.18	$0.00	$0.00	$0.00	$0.00	$0.00	$9,820.18
Contractor Overhead and Profit												**$9,820.18**
Home office cost, etc.	1	lump sum	15% of total construction cost		$9,820.18	$9,820.18	$0.00	$0.00	$0.00	$0.00	$0.00	$9,820.18
Mob/Demob												**$9,820.18**
Mob & demob of equip & personnel	1	lump sum	15% of total construction cost		$9,820.18	$9,820.18	$0.00	$0.00	$0.00	$0.00	$0.00	$9,820.18
Site Closure												**$25,000.00**
Report development	1	lump sum	Professional Judgment		$25,000.00	$25,000.00	$0.00		$0.00	$0.00	$0.00	$25,000.00
TOTAL CAPITAL COST						**$72,760.70**		**$19,237.25**		**$261,156.99**	**$0.00**	**$378,154.95**
OPERATION & MAINTENANCE AND PERIODIC ACTIVITIES - PER EVENT COST												
Wetlands Maintenance												**$1,175.00**
Biannual inspection	4	hrs	E 99 11 0403 CH2M HILL adjusted		$75.00	$300.00	$0.00	$0.00	$0.00	$0.00	$0.00	$300.00
Replanting												
Assume 10% of wetlands mitigation cost per inspection	1	lump sum	Professional Judgment		$875.00	$875.00	$0.00		$0.00	$0.00	$0.00	$875.00
Site Closure												**$15,000.00**
Report development	1	lump sum	Professional Judgment		$15,000.00	$15,000.00	$0.00		$0.00	$0.00	$0.00	$15,000.00

PRESENT WORTH CALCULATION
REMEDIAL ALTERNATIVE 3 - EXCAVATION, OFF-SITE DISPOSAL, AND WETLAND CREATION

Location:	Lab Area, NSF-IH, Indian Head, Maryland	Construction time:	3 weeks
Media:	Soil and Solid Waste - Upland and Wetland Areas	Operation time:	30 years
		Discount Rate:	3.3%
		O&M Contingency:	Fixed-Price

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
0	$378,155	Cost associated with excavation and disposal and wetlands mitigation	Capital	1.00	$378,155
1	$2,350	Two biannual field inspections and replanting	O&M	1.03	$2,275
2	$2,350	Two biannual field inspections and replanting	O&M	1.07	$2,202
3	$2,350	Two biannual field inspections and replanting	O&M	1.10	$2,132
4	$0	NA	NA	1.14	$0
5	$15,000	Site Closure	Periodic	1.18	$12,752
CAPITAL COST	**$378,155**				
2009 Dollar LIFETIME O&M	**$22,050**		**Lifetime Present Worth O&M**		**$19,361**
TOTAL IMPLEMENTATION COST	**$400,205**		**TOTAL PRESENT WORTH**		**$397,516**